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HEARINGS

ON

HOUSE BILL 35 (ON THE NICARAGUA CANAL)

BEFORE THE

COMMITTEE ON INTERSTATE AND FOREIGN COMMERCE,

HOUSE OF REPRESENTATIVES.

WASHINGTON:
GOVERNMENT PRINTING OFFICE.
1896.

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HEARINGS ON HOUSE BILL 35 BEFORE THE COMMITTEE ON INTERSTATE AND FOREIGN COMMERCE.

WASHINGTON, D. C., *Friday, March 27, 1896.*

The committee met at 10.30 a. m. for the purpose of a hearing on House bill 35, on the Nicaragua Canal.

STATEMENT OF HON. WARNER MILLER, OF NEW YORK.

Mr. CHAIRMAN AND GENTLEMEN OF THE COMMITTEE: I do not appear here to-day to advocate the passage of the bill before the committee, or any other bill. The Nicaragua Canal Company has never yet asked Congress to do anything in this matter, and it never will so long as I am at the head of it. Before I finish I will give you the history of the first movement in Congress in regard to this matter, and what the company and myself had to do therewith.

First, I want to give a brief history leading up to the concessions from the Nicaraguan Government now held by our company. In 1884 a treaty was negotiated by Secretary Frelinghuysen, known as the Zevalla-Frelinghuysen treaty, giving the Government of the United States the right to build a canal through the Republic of Nicaragua from ocean to ocean, and giving it a large amount of land upon both sides of the canal; in fact, giving the Government of the United States right over the entire line. That treaty came to the Senate, of which I was a member, and would undoubtedly have been ratified had it not been withdrawn from the Senate by President Cleveland immediately after coming into office in his first Administration. The treaty was withdrawn from the Senate and never returned.

Immediately after that a number of gentlemen in New York formed what was known as the Nicaragua Canal Association. It was not an incorporation or chartered company, but simply a syndicate or voluntary gathering together of twenty-five or thirty gentlemen moved thereto chiefly by the representations of Admiral Ammen; Mr. Menocal, an engineer in the Navy; Commander, now Captain, Taylor; Captain Evans, and other officers of the United States Navy who had given consideration to these matters of the canal.

This body of gentlemen raised a considerable sum of money—two or three hundred thousand dollars—and sent Mr. Menocal to Nicaragua, and through his services they secured the concessions made by the Government of Nicaragua, which concessions are now held by "The Maritime Canal Company" and the ones now under consideration.

Briefly, those concessions gave the owners the exclusive right to build and operate a canal across Nicaragua for a period of ninety-nine years, with certain conditions that it shall be extended for ninety-nine years, making nearly two hundred years for the life of the concessions. Mr. Menocal was sent to Nicaragua, because he had already made two surveys of the route under the direction of the United States Govern-

ment, and was familiar with the route, and his acquaintance with the people and knowledge of the question indicated that he would be a suitable party to make negotiations with the Nicaraguan Government, which were made successfully; and under those concessions the company has been operating ever since.

Upon Mr. Menocal's return, a company was organized, called the Nicaragua Canal Construction Company, under the laws of the State of Colorado, with a nominal capital of $12,000,000. The concessions obtained by Mr. Menocal were transferred to the Nicaragua Canal Construction Company. Money was raised and an expedition was sent out in November, 1887, with Mr. Menocal at the head of it, consisting of a large number of engineer officers. An establishment was made at Greytown, and finally surveys of the canal were commenced, which continued for a period of three years, during which time a large amount of money, something over $300,000, was expended in engineering work and preparing plans for the construction of the canal. While this work was going on the company became convinced that it ought to have a charter from the Government of the United States, in order to secure proper protection in Nicaragua in case of any internal or external troubles which might arise. So the company came to the Congress of the United States and asked for a charter. This charter was granted—a rare thing for Congress to grant a special charter. This charter was granted on February 20, 1889, and is known as the Maritime Canal Company of Nicaragua. It provided for the issuance of $100,000,000 of stock, and $200,000,000 if necessary. It gave the company all the ordinary and necessary powers of a corporation.

The Nicaragua Canal Construction Company transferred the concessions to the Maritime Canal Company chartered by Congress, which then became what might be termed the parent company, and it took back from the Maritime Canal Company the contract by which it was to build the canal and turned it over to the Maritime Canal Company for the securities of that company, which it was to take and negotiate as best it could. The amount of securities fixed was $150,000,000 of first-mortgage bonds and $100,000,000 of stock. The work went on under the Nicaragua Construction Company, and the affairs of the original Nicaragua Canal Association were turned over to the Construction Company, and, as I have just explained, the concessions were finally put into the hands of the Maritime Canal Company, which had been chartered by Congress.

In the spring of 1890, after I had retired from the Senate, the gentlemen having this matter in charge came to me and asked me to take the presidency of the Nicaragua Canal Construction Company. After considerable hesitation and consideration, I finally accepted it, and for five years past I have given it more time and have done more hard work in it than I have ever done in any private enterprise with which I have been connected since I have been engaged in business. From that time down to 1893 I raised in cash something over $3,000,000 by the issuance of the securities of the company, and I also procured a large amount of machinery and services for which the company paid in securities. The sum I raised myself, personally, and that which had been raised by the company before I became its president, amounts to something over $4,500,000, counting the machinery and labor at its actual value. The concessions required, first, that the final surveys and location of the canal should be made within eighteen months after a fixed time, and that within a year at least $2,000,000 should be expended in cash upon the work, and it was to be approved by the Nicaraguan *Government* itself.

When I came into the service of the company I found much less than $1,000,000 had been expended up to that time, and that the two years would expire on the 1st of October of that year. So I went to work to push the enterprise rapidly, and in order to comply with the concession and expend $2,000,000, which we were compelled to expend during the first year. I began work, and as a result of it I constructed a railroad eleven and a half miles from Greytown across the lagoon up to the point of the first lock. This was a substantial railroad, built under very great difficulties. During that entire season the land from Greytown to Lock No. 1 was under water, because it was the rainy season. The water was from 2 to 4½ feet deep, and the ground was covered with tropical vegetation. I was told by railroad men and engineers that I could not build this within the time, and that it could only be built by putting up trestles and piles the entire distance. I was not satisfied with that judgment, and finally called into counsel Mr. C. P. Treat, of Chicago, a young, energetic man who had made a fortune in the West building railroads. He had spent months going over the proposed line, with a view of making a bid upon a portion of the work. I asked him if he could build a railroad in the lagoon within the time at a reasonable price.

The object was, of course, to enable us to get into the foothills up to the locks and the great divide, because the length of time required to build the canal was based upon the length of time required to build the locks and cut the divide, a distance of 13 miles from Greytown. Mr. Treat went to Nicaragua. I sent an agent to Jamaica, and he sent a large number of workmen from Jamaica. I sent rails, ties, and a working train, and the work began with 1,600 men. The ground was under water substantially the entire distance, and the men worked in the water during the whole time. The railroad was constructed by cutting down trees and building a corduroy road some 4 feet in thickness of solid wood the entire distance. Upon this the track was laid, and sand (dredged from the mouth of the canal) carried by train was put upon this temporary track or wooden road until it was buried in the sand; and in that way the road was built for the entire distance, and to-day, after a period of five years, it is in fair order. I have passed over it at the rate of 20 miles an hour.

The road was constructed within the time at a cost, which our books will show, of $32,000 a mile, and was completed perfectly. That included 10 per cent commission paid to Mr. Treat for doing the work. We employed 1,600 men all the time, and but seven or eight died, and four of those were killed by accidents upon the road. Only four or five died from the effects of the climate. I speak of that to show you that Nicaragua is not so unhealthy a climate as has been generally represented. All these statements which I make can be verified by the records of the company.

We also purchased at the same time the entire dredging plant of the American Dredging Company, which had done substantially all the work at Panama and which originally cost nearly $2,000,000. We began the actual excavation of the canal at Greytown Harbor, and excavated to a depth of 17 feet a distance of nearly 2 miles, and the work remains to show for itself. We also began the construction of a pier which was to make the entrance into the harbor safe. We extended this pier a distance of 1,000 feet; finally it is to be extended nearly 6,000 feet. The construction of this pier, with a little dredging, made a depth of 14 feet over the bar, and it was maintained at that until the company, under stress of financial difficulties, was compelled to suspend

operations. We proved that there was no difficulty in opening the harbor. Before that time vessels had to lie out, and the freight was taken to the shore in lighters and hauled up in the sand by the power of human labor. This railroad was completed at this price, and it was a cheaper piece of work than any that ever has been done in the United States or anywhere else in the world. It shows what work will cost in that country. Mr. Menocal had estimated the cost at $60,000 per mile, and we built it at $29,000 per mile and paid Mr. Treat a commission of 10 per cent for his services and skill, which carried the cost up to $32,000. I mention this in order to show you the cost of building railroads in that country, and also to show you that we built at one-half of our engineer's estimate.

We went on with the work and with the negotiations. Immediately after I came into the company negotiations began with the Baring Bros., of London. They sent gentlemen to our office in New York, an engineer and a lawyer, to examine our affairs. Those gentlemen made an examination and returned to London, but within thirty days after their return the Baring Bros.' failure came on, and from that time to this there never has been a time when an enterprise of this character could have been floated, except at very low rates for its securities. The panic of 1893 came, and the construction company was compelled to suspend operations first, and finally it was compelled to go into the hands of a receiver. This, mind you, did not affect the parent company, which then held, and now holds, the concessions. Immediately after the Construction Company went into the hands of a receiver, a committee was organized and took the matter up, and after some nine or ten months of work, a new company was organized, the affairs of the old company were settled up, and every dollar of its obligations was paid. The new company was chartered by the legislature of the State of Vermont, and was organized last spring, which took the assets of the old company, the contract for building the canal, and the stockholders of the old company of course came into possession of a large part of the stock of the new company in exchange for their holdings in the original company.

This briefly is the condition of affairs at the present time. The Maritime Canal Company own the concessions from the Government of Nicaragua, and their standing with that Government is in a satisfactory condition. It is also in a condition to enter into negotiations for the procurement of money and for completing the work.

I said at the beginning that I was not here to advocate this bill or any other bill. This bill I have never read, although one of the members of the committee sent me a copy of it. Soon after I became president in 1890, I came to Washington upon some private business, and while sitting in the room of the Secretary of the Senate, Gen. Anson McCook, my personal friend, Senator Edmunds, of Vermont, came in and congratulated me upon having taken up the Nicaraguan Canal and wished me success. He asked, "How do you expect to get funds to build this canal?" I said, "We expect to do it in the usual way by issuing securities and selling them at such price as we can get. If we can not sell them at par, as we do not expect to, we may get 80 or 70, and if we can not do that, perhaps we can get 60. I shall undertake in some way to sell enough to get money to build the canal."

Senator Edmunds said to me, "Will you be able to sell them in this country?" I said, "I shall try to sell them here, and, failing in that, I shall go abroad; and of course as this country is taking vast sums of money from Europe to build railroads at the present time, it will prob-

ably be necessary to secure the bulk of the money abroad." He then said, "Where will the control be then, if the majority of the stock is held abroad?" I replied, "Of course the control will go to those who furnish a majority of the money with which to build it, and that should be the case." He said that ought not to be. It ought to be an American enterprise, and we ought to raise the money and have it controlled by the American people. I said, "Senator, as a patriotic citizen I agree with your statement that it ought to be an American enterprise, and we ought to make it such and keep it as such; but my duty to the stockholders is to get the money where and how I can."

A few days afterwards, I received a letter from the Foreign Affairs Committee of the Senate asking me to come to Washington to be examined by that committee of the Senate in executive session. I came, and remained here for several days. It turned out then that Senator Edmunds had introduced into the Senate in executive session a resolution instructing the Committee on Foreign Affairs to inquire into the condition of the Nicaragua Canal and the Maritime Company, and report to the Senate what the condition of it was, and what, if anything, the Congress of the United States ought to do in regard to the matter. Then things went on for several weeks and months. I made several visits to this city, being called by the committee. The committee finally said to me that they thought as a committee the Government of the United States ought to be interested in this enterprise, and perhaps ought to control it, and asked me to state upon what terms the company would be willing for the Government to go into the enterprise. I said, "I will go back to New York and consult the leading stockholders, and will give you an answer." I went back to New York, and consulted with the leading men in the enterprise, and replied by letter to Senator Sherman, chairman of the committee, that in our judgment the stockholders of the Nicaragua Canal Company would be willing that the Government should take control of the company, provided it would return to us the amount of money that we had expended upon the enterprise up to that time, and also give us stock of the Maritime Company to whatever amount they saw fit as a bonus, or bounty, for the time and energy we had expended and the risk we had taken in putting our money into the enterprise.

The members of the committee expressed their belief that that was a most liberal offer upon our part. The committee upon the strength of that prepared a report and a bill, which was reported to the Senate. The terms of the bill I do not remember, but the record will show what they were. It provided for the return of the money we had expended, and provided also that the Secretary of State and the Secretary of the Treasury should audit our accounts and determine what amount we had expended, and also provided for giving us some of the stock of the Maritime Company as a bonus for our time, trouble, and risk. What that amount was, I have now forgotten. No action was had upon that bill; but the next year the same committee took it up again, and asked me again to come before the committee, which I did, and gave them my suggestions.

During all this time, I had traveled over the United States and Europe. I had made three trips to the Pacific Coast. I had spoken in nearly every city of importance in the United States, before many of the Chambers of Commerce, and other bodies in regard to this enterprise, endeavoring to educate the people of the country up to the importance of the undertaking, thereby seeking to secure the cooperation of the American people in taking stock and bonds; but I found,

wherever I went, that after the Senate Committee had reported its first bill, the people generally came to the conclusion that it ought to be a Government enterprise and be controlled by the Government, instead of by private individuals. The people said that if they put their money into it, the Government will come in and take the canal and we shall simply get a return of the money, without any especial profit being allowed for the risk which we may take. I then came before the committee with this knowledge.

I had traveled over the country three times, almost 50,000 miles, made speeches, and written many articles. I told the committee what I had found to be the opinion of the people—that the Government ought to control it. I said, "If you want to go on with this enterprise, I will make this suggestion: Let the Government guarantee the bonds of the company for whatever amount may be necessary, and for this the Government can take and put into the Treasury of the United States either $70,000,000 or $80,000,000 of the stock of the company, and absolutely own it, because of this guaranty, upon the same principle that one man pays another 5 or 10 per cent for indorsing his note." The Government to indorse the bonds and receive three-fourths of the stock, thus becoming the controller of the situation. The Government was to appoint ten of the fifteen directors, and one director was to be appointed by Nicaragua and one by Costa Rica; the third would be elected by the outside stockholders. Substantially, that kind of a bill was reported, the exact terms of which I do not now recall.

Time went on, and last winter this same bill was reported by Senator Morgan, with some changes, and it finally passed the Senate. The company was not entirely satisfied with its terms, because it gave the company no power whatever in deciding how much money had been expended by the company, and whether the expenditures were just and right. It provided that the Secretary of State and the Secretary of the Treasury should be the absolute judges as to the amount expended by the company. We thought it ought to have been decided by a commission, of which the company should appoint one and the Government appoint one, and they, failing to agree upon any matter, should appoint the third, and then their decision was to be final. The amount of stock set apart for us was less than we thought was just, but we made no special complaint, and I presume that if the bill had been passed and become a law the stockholders would have surrendered their rights and would have given the Government the entire control. My belief as an officer of the corporation was briefly this: The Government to guarantee the bonds at 3 per cent for the building of the canal, and the revenues of the canal were to be set apart first—supposing the canal to cost, in round figures, a hundred million dollars—three millions to pay interest——

Mr. PATTERSON. What is the amount of the capitalization, $100,000,000?

Mr. MILLER. Yes, sir; the capital was not to be disposed of. About $1,000,000 was estimated as the probable cost of maintaining and improving the canal, which was about the cost of maintaining the Suez Canal, and $1,000,000 was to be put into a sinking fund, so that in sixty years the sinking fund would have entirely paid off the bonded debt. The Government would never have advanced a cent, and would be the owner of $70,000,000 or $80,000,000 of the $100,000,000 of capitalization.

We neither sought nor opposed the passage of that bill. We have refused to have anything to do with the passage of any legislation.

This is the first time in five years that I have ever appeared before a House committee, or mentioned the matter even to the Member of the House from my own district. Mr. Sherman, the Member from my district, can tell you that I never presented the matter to him in any shape whatever. I said to Mr. Sherman that I would not come before your committee unless I was requested to do so. We have never asked for a hearing, and under no circumstances will we come here to ask anything. If, following out the suggestions of Senator Morgan and Senator Edmunds, the Congress of the United States sees fit to pass a measure which is just and fair to us, undoubtedly the stockholders, who are nearly all Americans, will accept that decision and turn over the control of this great enterprise to the Government.

Mr. SHERMAN. You might say further, that you declined even to express an opinion to me of your preference as between three bills which I handed you.

Mr. MILLER. Not only that, but I have not read them. In fact, I declined to read them. We have felt that if the people of the United States thought that this enterprise ought to be an American enterprise, we as American citizens would not stand in the way of it, no matter what our prospective profits in such enterprise might be. It is now five years since the Government first took it up, and we have felt for several years that we had a cause of grievance against the Government in this matter, for, since it became known that the Senate was considering it, and had reported a bill, it became substantially impossible to get any money anywhere.

The American people had said Congress ought to do this, so that it can control tolls and run the canal for the benefit of the people.

Foreign bankers have said: "We can not take this up now, because by the time we have raised and expended several millions on it the Government of the United States will step in and take it away from us, and we shall get nothing but our cash in return. In other words, our profits will never be realized, and therefore we will not touch it until the Government of the United States has decided what it will do." We have been in this condition that during all these years it has been impossible to raise money, except from the original subscribers. Now, these men who have furnished money and have been assessing themselves to keep up the property, keep up an office, and all the necessary expenses connected with an enterprise like this, could not abandon it entirely. The result has been that the old subscribers have been compelled to add to their subscriptions. When the company was reorganized every one of the old stockholders who were able remained and paid their assessments of $3.50 per share.

Mr. DOOLITTLE. What is your belief relative to the ability of the company to raise money, if the Government had not interfered or had not taken the matter up?

Mr. MILLER. I have not any doubt that, if there had not been any interference on the part of Congress, we could have raised the money. I was appealing to the American people, and received everywhere cordial support until this matter was introduced into Congress; then I was met everywhere with the proposition that it ought to be a Government matter, and I found that private individuals would not take it up. Since 1893 the financial situation has been bad, and it has been difficult to obtain money. The company would have been justified in offering bonds at low prices, which would have appealed to the speculative spirit of the American people and foreigners. I have no doubt that since 1893 we would have been able to get $25,000,000.

Mr. PATTERSON. I think you correctly reflect the opinion of the United States when you say the people desire the Government to own and control this canal; but the one question in the minds of some of us is as to the practicability of constructing the canal within reasonable limitations of cost.

Mr. MILLER. That I am coming to, with the permission of the committee. I want to have the position of the company in regard to this fully understood. It is constantly being misrepresented by its opponents, and also by people who are not familiar with the facts, and therefore I desire to put before the committee the exact conditions existing from the beginning down to the present time. Last winter a bill passed the Senate. There was not time to get it up in the House, owing to the fact that the 4th of March was near; but there was placed upon one of the appropriation bills $20,000, to be expended by a United States Commission to be appointed by the President to be sent to Nicaragua for the purpose of making an investigation and report. That appropriation was passed, a Commission was appointed, and they made a report to the President, which was finally transmitted to Congress. The object of the appointment of this Commission, of course, was well understood; that it was to gain time and delay. The friends of the enterprise in the Senate and House, as I understand it, accepted this appropriation in good faith as the only thing that could be done. No one connected with the company had anything to say about it.

Immediately after it became a law, I called the directors of the company together, and we voted to spend whatever money was necessary to put the line in condition, so that it could be seen by the commissioners. The appropriation of $20,000 made by the Government for three commissioners, after paying their salaries, left very little for the necessary work of investigation, and had not the company come to the aid of the commission by expending its own moneys the investigation would have been impossible. The company expended for this purpose in opening up the line and rebuilding camps for taking care of the commissioners and the service of the men nearly as much as the Government had appropriated; and the company turned over to the commission, when it sat in New York, all its notes and surveys, which had cost nearly $500,000. Those were put into the hands of the commission unreservedly.

Mr. PATTERSON. Who were the Commissioners?

Mr. MILLER. Major Ludlow, Mr. Endicott, and Mr. Noble, a civil engineer from Chicago. The impression has gone out that the report was adverse to the canal, but a careful reading will show that the report is not adverse. It makes many recommendations in regard to changes in the proposed line and in the works. It calls in question the wisdom of some of the plans made by the company and recommends changes which would largely increase the cost of the canal; and after making a detailed estimate of the cost, it says that it lacks sufficient data by which to make a proper estimate. It finds, however, as was found by several engineers throughout the world, both great and small, who have examined it, that the plan is entirely feasible; that the canal can be built, and I may add that it is, in the judgment of all the best engineers who have examined the matter thoroughly, the only possible route across the isthmus which can be constructed at a reasonable cost. This Commission places the cost at $133,000,000.

Now, I want to call your attention to some of the statements of this Commission. I do not want to weary you, or take your time by going into a detailed examination from a technical or engineering standpoint,

because Mr. Menocal, the engineer of the company, who has made three surveys, two of them for the Government, and who has spent many years in examining this route, is perfectly able to defend his surveys and estimates. Having the report of the Commission before him he has prepared and submitted for your use an elaborate discussion of this question from every standpoint, and as president I am perfectly willing to stand upon that argument before the best engineers in the world.

When in London our plans were submitted to Sir John Cood, who was the leading engineer of England and who planned and executed many important harbor works for the English Government. He studied the plans for several weeks, until he was thoroughly familiar with them. He said that they were practicable, and the only change he recommended was that the cut through the great rock divide should be increased from 80 to 100 feet in width, but that the harbors at Greytown and Brito were correct in plan, and if carried out would furnish two great safe harbors for this canal. I simply mention that because we have to rely upon the testimony of engineers, and we have in Sir John Cood a man whose opinion is worth much in a great work like this, and it is proper and just that I should refer to him.

Four years ago when I went to Nicaragua I spent more time in examining the line than this Commission spent, for they only spent fourteen days on the line of the canal, and there are parts of it they never saw. When I went over the line, I took with me Mr. Donaldson, one of the principal engineers of the Manchester ship canal, now chief engineer of the London docks.

He made a thorough, careful, and elaborate study of the canal and the plans of our company, and reported to his principals, Messrs. Walker & Co., contractors, that the canal was feasible, and that the cost of the canal would be less than $100,000,000.

Mr. BARTLETT. In the report of the Government Commission I think it is stated that there is no precedent for the construction of a dam such as the Ochoa dam.

Mr. MILLER. I will come to that. If this Commission had had a little experience in such matters it would have known better. I understand that the chief has been sent abroad to examine similar works. I think if the Government had sent him abroad before he made his investigations in Nicaragua he would have been better able to have spoken in regard to it.

The report of the Commission begins and ends by criticising the plans of the engineer, but the Commission is compelled substantially to admit that finally the work as planned can be done. The first proposition they make is that the entrance to Greytown Harbor shall be moved about a mile and a half to the east. The reason given for it is of no value whatever. The entrance as laid down by the company is the original entrance where, in 1849 and 1850, during the California gold excitement, vessels went in with over 20 feet of water. It was an open harbor for many years, but finally a bar was formed. The company naturally supposed that a good place to make an entrance to a harbor would be where one existed many years before, and they adopted this place, but only extended the pier out 1,000 feet and got 14 feet of water. It can be maintained at little cost. If we had had money we would have completed the pier 6,000 feet, where we could have obtained 30 feet of water without difficulty, and it would have been maintained at less cost than the cost of maintaining the entrance to the Suez Canal.

Mr. PATTERSON. How did you construct that pier?

Mr. MILLER. It was constructed by putting down piles in rows. We made it 40 feet wide and filled it in with stone and concrete. Since the work was commenced on that point the whole engineering world has come to adopt a cheaper method of building. The great breakwater on the Columbia River was constructed by driving piles the whole length of the proposed pier and putting a railroad on the top, by which the work was carried out and placed the entire length of the pier, constituting what is known as riprap or a loose wall projecting out so that the force of the waves is destroyed. The reason the waves do not do any harm is that there is a gradual slope, and the force of the waves is broken and no harm is done the main work. It is upon that plan that the great breakwaters are now built.

Mr. PATTERSON. Are these wooden piles not subject to being spoiled by the toredo?

Mr. MILLER. They would be in time; but they are only a temporary structure. I found them in Amsterdam on my visit to Holland. They have built piers there on the plan of the Eades jetties at the mouth of the Mississippi River. They are breakwaters built with perpendicular sides, with artificial stone blocks packed with loose rock. The result of that kind of structure is that the waves come in and beat against this work without doing any harm. Our work was built by driving piles and putting a railroad track upon it, and bringing rock and dumping it into the ocean, making a pier which the waves could not destroy.

Mr. PATTERSON. And the rock excavated is used for that purpose?

Mr. MILLER. Yes, sir.

Mr. PATTERSON. What is now the condition of the canal, as far as you have constructed it out from Greytown through the alluvial soil?

Mr. MILLER. The Commission reports that the banks stand perpendicularly, just as they were built five years ago. There has been no change. The damage there is much less than it is in a northern country on account of the climate, there being no frost. It stands in perfect repair.

In reference to the entrance to the harbor being moved a mile and a half east, I would say that, in the first place, we could not go there, because the Nicaraguan Government would not allow us to go there. If we went there we would be in Costa Rican territory, and our concession demands that the canal shall begin and end in Nicaraguan territory. The line dividing the two territories is a short distance to the east of the entrance of the harbor. It was natural to suppose that we would go where the work would be done the easiest and cheapest, and investigation will show that it would have cost $1,000,000 more to build it where the Commission suggests than where it is built.

Mr. PATTERSON. What is the estimated cost of improving Greytown Harbor?

Mr. MILLER. We will furnish that to you. It is in the engineer's estimates. The line starting from Greytown Harbor for 10 miles to the foothills runs across low ground or lagoons. The Commission recommends a change of the line a little farther to the south or east. No good reason is given for it. The company spent months and months surveying that portion of the line in order to get the best location. We have run over 4,000 miles of line by the theodolite. We think we know quite as well as the Commission the scope of that country. If we change the line south, the river would have to be changed. The line has been kept in the present direction so as to avoid the river. This Commission suggests a change, but makes no provision for changing

the river. Mr. Menocal's argument will show conclusively the condition in that respect.

We next come to the question of locks. They admit that the locks are all right. They say that the lift can be made without doubt. They suggest, however, four locks instead of three. The object of this is not stated. Of course it would increase the cost and the length of time it would take for a ship to go through the canal. There can be no good reason for it. Instead of diminishing the lifts, it is quite possible that those lifts might be done in two instead of three. With hydraulic machinery in France they lift more than 50 feet in a single lift.

In short, there is not a single recommendation of the Commission which is not in the direction of increased cost. It would also increase the time which would be taken to build the canal. It would seem that they supposed they were representing a Government work in which the amount of money was unlimited, and the question of cost had nothing to do with it. This company started out to build an available canal which would accommodate the commerce, and do it at the least possible cost. That has been the plan upon which railroads and canals have been built. The Suez Canal, the great prototype of all canals, was built first to a depth of 26 feet, and was so narrow that vessels could not pass, and every 4 or 5 miles turnouts were made, so that vessels could pass; but now they, having made a great success of the canal, are deepening it to 30 feet and increasing it to the width of the proposed Nicaraguan Canal.

Our canal was laid out with a width of 125 feet on the bottom. The Commission propose to reduce it to a width of 80 feet for the first 10 miles from Greytown and make turn-outs, which would cost as much as the plan of the company would, and it would be impossible for vessels to pass. The only possible reason we can think of for their making these recommendations is that they did not want to approve anything that the engineer of the company had done. They changed the canal from 125 feet at the bottom for the first 10 miles, and farther up they propose different widths up to 300 feet, simply, I suppose, because the engineers of the company had decided upon the other widths.

We then come to the divide. With that they find no fault, except to say that we have not made borings. They claim we ought to have made more borings, so as to be sure of it.

Mr. PATTERSON. Did you find the same material in your borings?

Mr. MILLER. Yes, sir. There is no tendency of the rock to slide or disintegrate. The indications of centuries show the character of the rock to be absolutely fixed.

Mr. PATTERSON. It is of uniform formation?

Mr. MILLER. Yes, sir. We have been able to show exactly what the rock is. Between this and the divide at Ochoa comes in the dam where embankments have to be built. They find the embankments can be built. The only serious thing which the Commissioners say about it is, that in case of war somebody might destroy it with dynamite. I suppose that is true. I suppose, too, that somebody might blow up this Capitol.

Mr. PATTERSON. You have two locks between Greytown and the Ochoa dam?

Mr. MILLER. We have three locks on each side, making the rise 110 feet. There are six locks in all; but the Commissioners recommend eight in all. We now come to Ochoa dam. This is the key of the whole plan. Ochoa dam is some 50 to 60 miles down the river and 20 to 40 miles from Greytown, direct across, as the canal goes.

Mr. PATTERSON. About what is the size of the San Juan River and its flow?

Mr. MILLER. San Juan River is a large navigable stream; is from 40 to 100 feet deep; it is 500 to 1,500 feet wide.

Mr. PATTERSON. It has about as much flow of water as the Ohio above Cincinnati?

Mr. MILLER. I am not familiar with that; but the proposition is to build a dam 65 feet in height. That raises the water of the San Juan River to the level of the lake. Much of the low land will be flooded back to the foothills, so that a large part of this will be an addition to the lake. That makes a greater reservoir for holding the floods of the country. At the point where the dam is to be located there is no rock bottom to be found within any reasonable distance to which the masonry could go down. As a result of that, it became necessary to find some other way to build the dam and rest it upon clay bottom, so as to make it permanent and safe. This plan of the company, after being argued for a long time by the Commission, is finally held to be practicable by some changes being made in its construction. That dam is simply a rock-filled dam. The rock is to be taken out of a cut and by railroad to be carried to the Ochoa dam and dumped into the river. It is built upon the same plan as piers or bulkheads, of loose stone weighing from 5 to 10 tons. It will spread out, being 500 feet on the bottom and brought up to a crown on the top, and its weight will be many times greater than the weight of the water which will come against it; consequently it will not be moved by the water. It will be made tight by depositing gravel and clay on the upside. There are a large number of great dams in India which are four to six times as long as that, but not as high. They are built in the same manner, with loose stone and filled in with clay material, which makes them tight.

This matter of the dam is gone through in several pages of the report and finally the Commissioners say that modern engineering can do any, thing necessary, but that the abutment ought to be made stronger; and they suggest that the top construction be carried on after the water is turned out through the San Carlos River. This river is in Costa Rican territory, and on the eastern side of the river there are low ridges of rock which can be used as wasteweirs for the canal. They suggest that wasteweirs be make sufficient so that the river can flow over them, and that this dam be constructed dry. I have all my life, as a manufacturer, been building dams and hydraulic works, and therefore have some practical knowledge of works of this kind. This committee can see instantly the folly of such construction. Suppose you turn the water out through San Carlos River and build the dam dry, as proposed, and then turn the water back on the completed dam. There will be a great deal of settling of the stones, undoubtedly the dam would settle many feet, and it might be greatly injured; but if built when the water is on it, no settling is possible after completion.

Mr. BARTLETT. What is the cost of this four miles of construction?

Mr. MILLER. We say that it will cost less than half what their estimate is.

Mr. BARTLETT. Suppose the dam gives away, would it destroy the canal?

Mr. MILLER. No, sir. The water would go down the original channel of the San Juan and the canal would be left dry and uninjured.

Mr. BARTLETT. The Railroad News had an article in which this seemed to be regarded as an objection, and it intimated that the dam would be taken away.

Mr. MILLER. There is not a particle of danger in that case. Out of great precaution, if you want to make it absolutely certain that nothing can ever harm the dam, you have simply to build it 8 or 10 feet higher than proposed, so that the water can not pass over it—taking the water over the wasteweirs, to be made along the San Carlos River.

Mr. BARTLETT. Some years ago there was published in the American Law Review an article on the legal aspects in regard to the proposition contained in the original bill. It was intimated that after the bonds were paid off the Government would be no longer interested, because she would be entitled to none of the stock, and the stock would fall back into the hands from whence it came.

Mr. MILLER. That remark was made in reference to the first bill. According to the bill which passed the Senate, the Government was to take the company and have ten directors out of the fifteen, and was to guarantee the bonds and take from $70,000,000 to $80,000,000 worth of the stock. The Government would have three-fourths of the stock of the company; consequently own and control the canal.

Mr. PATTERSON. The first proposition contemplated the Government indorsing the bonds, and placing the stock in the hands of the Government as collateral security; now the plan is for the Government to become absolute owner of the canal.

Mr. SHERMAN. If the canal prove a success it would be the best investment the Government ever made.

Thereupon the committee took a recess until 2 p. m.

AFTERNOON SESSION.

STATEMENT OF HON. WARNER MILLER—Continued.

The CHAIRMAN (to Mr. Miller). If it pleases you to go on, anticipating the arrival of the balance of the committee, it will suit those of us who are here, but it is just as you please.

Mr. MILLER. I will be glad to do whatever you desire.

Mr. PATTERSON. I will say I will have to leave here by half past 3 at any rate, and I would like for the Senator to proceed.

Mr. MILLER. I do not recollect my last statement to the committee, and, as the stenographer of the morning is not here, I am not able, perhaps, to commence exactly at the point I left off; still, I had substantially finished the discussion of the Ochoa dam. I will simply say in regard to that one thing more. Of course the Ochoa dam has to be built upon a sand bottom. The question as to whether that is sufficient or not is not a question of theory but settled by any quantity of great public works all over the world. The president of the Illinois Central Railroad told me yesterday nearly all of the great bridges upon the line of his road and many of those across the Mississippi River rested entirely upon a sand bottom where the superstructure was very heavy and the piers built of cut stone and weighing many hundreds and thousands of tons. The ship canal of Amsterdam in Holland—all of its superstructure rests upon sand. When I was visiting there they were then constructing a new lock much larger than the old lock, a lock about the size proposed in this canal, and I saw its foundation, which rests entirely upon sand. It is unnecessary to repeat illustrations regarding the fact that any superstructure of any weight to-day can be built resting entirely upon sand.

Mr. PATTERSON. Before you proceed to take up another question, please let me know how far it is from Greytown to the foothills by way of the canal, if you carry it in your memory.

Mr. MILLER. Beginning at the foothills—that is to say, where they put in the locks—to here [illustrating on map] is some 15 miles. The whole distance up to Ochoa, as we reckon it, is about 31 miles, or a trifle over.

Mr. PATTERSON. From Greytown?

Mr. MILLER. Yes.

The next point of criticism of the Commission is confined to the river from Ochoa to the lake, a distance of, I think, 56 miles, if I now recollect correctly. Much of that way the river is deep enough and wide enough for the largest vessels. There are three rapids, however, which are now navigable and over which small vessels pass. These rapids will have to be taken out. The dam at Ochoa, as I said, elevates the water of the San Juan River from this point to the lake, and brings it to the same level as the lake, so that it has free navigation from Ochoa to the lake and across the lake, and so on to the Pacific. In the parts of the river where we have to make excavations through rock or soil, the company had estimated for the bottom of the canal a width of 125 feet. That is the width of the Manchester Ship Canal and a little more than that of the Kiel Canal, and very much wider than the Suez Canal as finished. The Commission recommend that it be increased to 250 feet, or doubled; for what reason I do not know.

As I told you at the beginning, they had recommended that the first 10 miles through the lagoon be reduced from 125 feet to 100 feet, but when they come to the river they recommend an increase of from 125 feet to 250 feet. When we come to the lake here, there is a deposit of mud extending out for 14 miles, more or less, on which a large amount of dredging will have to be done. There the company has made the bottom of the canal 150 feet wide, and there the commission recommend that it be made 300 feet. The only object of that can be, of course, to increase the cost of the work. The width of 125 feet is sufficient for any vessel to navigate and it is sufficient for vessels to pass, and 150 feet in the lake is ample there. We might say it would be better to have it 500 or 1,000 feet wide or any width, but the company proposes to build a commercial canal to meet the wants of commerce and to build it at the least possible expense, and we simply submit that a width which is greater than that of the Suez Canal and equal to that of the Manchester Canal or any ship canal in the world, ought to be wide enough for this, and it is simply a wanton waste of money and largely increasing the cost of this canal to add to its width.

There is no difficulty whatever in marking this channel perfectly so that vessels can not by any possibility get out of it. If any of you have been down at Morgan City, on the Gulf of Mexico, you have seen a channel several miles long running through a great waste of mud and shoal water in which the channel is very narrow, and not as wide as this, where it is thoroughly marked, say every 100 feet, by poles set up, making a guide for ships passing out and in.

Mr. DOOLITTLE. May I ask if any storms of any consequence visit this portion of the lake which would make a wider canal necessary, and if there are any heavy winds which would make the steering difficult?

Mr. MILLER. The reports of captains and men who have been on the lake since 1849 say that there will be no difficulty in the navigation of a channel of 150 feet wide, if it is thoroughly marked. The cost of a work of this kind depends upon two things chiefly: First, the quantity of materials of all kinds that have to be moved; and, secondly, the cost

of labor, which makes the unit of price. This Commission, in arriving at an estimate of cost of $133,000,000 for this work, have first, as I have shown you, largely increased the quantity of material to be removed by increasing the width from 125 feet on the river to 250 feet, and on the lake from 150 feet to 300 feet. They have then increased the quantities in other directions, but they arrived at the cost of the unit of removing this material by taking data which are inadmissible, and most of which are incorrect. Their price was the price prevailing years ago, when the cost of doing this kind of work was very much greater than now. In fact, the estimate of the company was made upon a basis of cost which does not prevail anywhere in the world to-day; that is to say, the present cost is greatly reduced. For instance, we have estimated, beginning at Greytown, the cost of dredging at 20 cents a yard for deepening the harbor and dredging the first 10 miles, and that was a fair estimate when it was made, with the machinery then in existence, by which that kind of work was done.

The machinery which we bought from the Panama people and brought there was of a superior kind at that time, and the result was that the dredging which we did at Greytown—and we kept a perfect and accurate account of it, and I have here a transcript from our books showing that at the beginning of the canal we took out some 700,000 cubic yards at a cost of only 11 cents per cubic yard. Of course we did it under adverse circumstances. We worked the plant only 10 hours a day instead of 24 hours a day, as the company would do if it had had abundance of funds, but we did it at 11 cents per cubic yard, as our books show, while our estimate was 20 cents per cubic yard. This Commission increases it from 20 to 25 and 30 cents per cubic yard. Now, what are the facts to-day? All the machinery down there now can be discarded, and to a great profit, because machinery to-day for dredging is much more effective than that was. For instance, to-day dredging is being done at Mobile under contract at 7 cents a yard, and the material is taken 6 miles to sea. It is being done under a contract at 7 cents a yard, and the contractors tell me they are entirely satisfied with their profit. We had offers from dredging companies several years ago offering to do all the dredging of this canal at our estimated price, but this Commission, without informing itself as to what the cost of this kind of work throughout the world is to-day, simply increases our estimate from 10 to 25 per cent.

Our rock excavation in this great divide here, which is nearly 3 miles long, and which, I think, calls for some 8,000,000 cubic yards or more rock to be taken out, we estimate at $1.50 a cubic yard, and then we allow for transportation to Greytown to put in the breakwater and also to be put in the Ochoa dam 50 cents per yard. They are not satisfied with that, but they largely increase that unit of price. Now, what are the facts to-day? If this committee wants to know what rock of that kind can be excavated for, let me ask you to send for some of the leading contractors who are now doing work upon the drainage canal at Chicago. I visited that last year in connection with the contractors and chief engineers, and there I found that great work being done under contract, and the highest price was 76 cents a yard, and the contractors told me they were entirely satisfied with the profits they were making. I believe it is entirely possible to-day to let a contract for all this rock excavation for less than $1 per cubic yard. I have here a

letter from Thomas A. Edison, giving what it cost to move rock to-day with the improved machinery and system which is adopted:

ORANGE, N. J., *December 18, 1895.*

MR. HORACE L. HOTCHKISS,
35 Broad Street, New York.

MY DEAR SIR: Replying to yours of the 17th, I beg to say that at our works at Edison, N. J., we mine low-grade iron ore (magnetic oxide and feldspar).

All our work is in an open cut, and over the cut we have a traveling crane 200 feet span, with which we load the ore into the iron skips or boxes (each holds about 5 tons) and also place the loaded skips on the railroad can, which deliver the ore to our crushing plant, an average distance of about 2,000 feet. We use steam drills and blow out several thousand tons at each blast, and try to get the pieces out as large as possible, not exceeding 5 tons, as with our appliances a man can load a 5-ton piece as quickly as one 500 pounds. Our cost per ton (2,240 pounds) for drilling, blasting, loading the ore into the skips (by hand, as at the time this cost was made our loading appliances were not ready, so we were compelled to load by hand labor), putting the skips on the can, and delivering the can at the crushing plant, on 1,154 tons per day of ten hours, including all material, labor, coal, repairs, etc., was 19.71 cents per ton.

With the appliances we are putting on the crane for loading the ore into the skips and with our plant full capacity (5,000 tons per twenty hours), we fully expect to deliver the ore at crushing plant for from 12 to 14 cents per ton, and probably less.

Yours, very truly,

THOMAS A. EDISON, *President.*

P. S.—Granite as per sample in office weighs 4,540 pounds to cubic yard = 2 tons 60 pounds per yard.

Mr. MILLER. Now that converted into yards, in round figures two tons would equal one yard. That would make the cost of taking out the rock upon this plan in the one case where it says 19.71 cents per ton or 40 cents per yard. He says, "We fully expect to deliver the ore at crushing plant for from 12 to 14 cents per ton and probably less," or from 24 to 28 cents per cubic yard. Now those are actual facts, but this Commission disregarding all that puts the cost up to $1.75 per cubic yard and then adds 50 cents for quarrying it in blocks of from 5 to 10 tons, which would be large enough to put in the Ochoa dam. Taking these figures of Mr. Edison, the estimates of the Commission are from three to five times the actual cost to-day of doing this work.

Now as to the cost of labor down there. The Commission say of course in that climate and under those conditions the cost of labor will be much greater than in the States. Let us see. We have spent $4,000,000 or $5,000,000 there chiefly upon labor and we know something about it. We had at one time 2,000 men, Jamaica negroes, and the cost I have here exactly. We paid colored laborers 20 soles per month and subsistence, and occasionally we paid 25 soles and subsistence. The sole is the money of Nicaragua, a silver piece equal to about an American silver dollar.

Mr. PATTERSON. You mean 20 soles per month?

Mr. MILLER. Yes, sir; it would be $20 in silver or $10 in gold at the present time. The actual cost of subsistence was 11.50 soles; that, added to the other, makes 31.50 soles and 36.50 soles per month, or in the one case $15.25 in gold per month and in the other case $18.25 in gold per month. At that time the rate of exchange and value of silver made the sole worth about 72 cents. Now it is worth 50 or less. In other words, you can get anywhere from 10,000 to 20,000 laborers of the West Indian islands, who are perfectly acclimated, for less than one-half you pay labor in this country. Now, assuming that the labor there is only one-half as effective as it is here—and we are prepared to show that it is more than that; that it is nearer two-thirds as effective there as it is here—it brings the cost of labor in Nicaragua for all this kind of work,

common labor, to substantially the same basis as it is in the United States.

All these statements I make here are verified from the experience of this company and from their books and accounts, so that there should be no addition to the cost of that kind of labor because of the climate, and the record which I gave you this morning in regard to working 1,600 Jamaica negroes for six months and only four dying, and they were worked in the wet season, shows it is not in the common acceptance of the term an unhealthy climate in which to do work for that kind of laborers, who are of course acclimated and are accustomed to it. The skilled laborers, the engineers, mechanics, etc., of course, are from the United States, and we paid them no more than they received here; but if the work was going on with a large number, with 10,000 or 20,000 men there at once, the demand for skilled labor would probably lead to a demand for a larger compensation than received in the United States, but the bulk of the labor and bulk of the cost is, of course, the common labor.

The company have estimated the cost of excavating rock under water at $5 per cubic yard. There is a large amount of rock in the river at the three rapids of which I have spoken, to be excavated. It has all been estimated at $5 per cubic yard. We submit that that is an extravagant estimate. The Government at the Saulte and the channel below it is doing this work at a cost of not more than one-half of that, or substantially $2.50 a yard, and the same machinery and appliances can be used at Nicaragua as there used and the work be continued the whole year, whereas at the Saulte they have to suspend entirely during the winter season, therefore costing more than it would otherwise.

Mr. PATTERSON. Would not that depend somewhat upon the character of the rock?

Mr. MILLER. Yes; quite likely it would.

Mr. PATTERSON. What about the rock in the bottom of the San Juan River?

Mr. MILLER. It is like all the rock of the country, which is largely of igneous or volcanic form, and while it is hard it drills readily, of course, with a diamond drill, and in blasting it comes out in pieces large enough to be handled successfully; and we believe it is a no more expensive rock to quarry than the rock found at the Saulte, or not much more expensive than the rock found on the drainage canal at Chicago. But even it it is, the prices we have estimated under present conditions are extremely large, because, as I say, we have made a basis upon a system of doing it which is much more expensive than it is at the present time. Now, a dredging plant to-day—a suction dredge doing this work at Mobile and some of the ports of Mexico—has demonstrated that the principal part of the dredging can be done at an actual cost of not exceeding 5 cents a cubic yard, whereas our lowest estimate is 20 cents. The Government has just had constructed for use of the Mississippi River Commission a great dredge, which, I am told by the builder, is enabled to handle 6,000 cubic yards an hour, which is twice as much earth as the entire United States Army can handle if it was furnished with wheelbarrows and shovels. It is all done by one machine.

Our estimates were made when it was assumed in the harbor it would be necessary to put the material into scows and tow them out to sea 4 or 5 miles to be dumped. Nothing of the kind now is done. The material is pumped through a pipe and discharged directly from the dredge at a distance of a half, three-quarters, or a mile and dumped off in the swamps along the canal, and not a particle put in a scow

and towed out to sea. The builders of a modern dredge would like nothing better than to have a contract to do this work at our estimate instead of increasing it.

In the building of the locks of course a large amount of concrete has to be used. The bulk of the locks is to be made of concrete; that is, a mixture of Portland cement, sand, and broken stone. We have estimated all of that at $6 a cubic yard in place. The Commission find that that is not sufficient, and they raise the price of that to $9.50 a yard because they say some of the work on the Hennepin Canal cost that much to do there. Now let us see. The work done in Alabama by the Government, now substantially completed, on the Coosa dam cost $4.50 a cubic yard for concrete in place, and the cost of the Portland cement was about $2.50 a barrel delivered. Portland cement can be laid down at Greytown from England or Belgium in shiploads at $1.50 to $1.75 per barrel. There is no duty, of course, in Nicaragua upon anything that the canal company chooses to take in for use upon the canal. We have as fine sand as can be found anywhere in the world for masonry, and of course the rock is free, as it is taken out of the cut. We can get offers from responsible parties giving bond to do all the concrete work at $6 per cubic yard. There is no doubt it can be done actually at from $4 to $4.50, but the contractors must necessarily make a profit, and when they go into a country like Nicaragua they expect to make large profits; but there is no trouble at all about furnishing contractors who will do the work at our price named, which is $6 per yard.

We submit that this estimate of the Commission is simply out of all character and uncalled for, and no reason can be given except a desire to increase the cost of the whole canal. We find this increased cost based upon two things, an increase of the quantities by increasing the prism of the canal, and, secondly, by depreciating the value of the labor, which is unfounded. Now, modern methods of dredging and excavating have been so much improved since our estimates were made that we might safely, if we saw fit, reduce our estimate upon those things at least 25 per cent, and in many cases 50 per cent. Upon that point of the case Mr. Treat, of whom I spoke this morning, who went down to build the railroad for the company and is an able man and very reliable, and who spent nearly a year in Nicaragua, wrote me a letter some time ago stating that he would take the entire contract for the canal and do all the work at the price named by our chief engineer in his estimate, we of course guaranteeing the quantities to be not greater than those stated in our estimates. Further than that, he offered to build the entire canal for $90,000,000 and take no guaranty as to the actual quantities. If the quantities exceeded our estimates he was to do the work complete, giving us the canal 28 feet in depth, 125 feet at the bottom at the beginning, 125 feet in the river and 150 feet in the lake.

I only mention this to show you it is possible to bring before this committee a number of skilled and able contractors in this country who will verify every statement I have made as to the cost of doing this kind of work at the present time. The builder of this new dredge, of which he is justly very proud and which has demonstrated its ability to handle 6,000 cubic yards an hour, is here in the city, and in talking with him in regard to it last night he confirmed all I have said to you in regard to this matter, and we hold there is no necessity or occasion for making an increased size of this canal at the present time. Twenty-eight feet of depth is deeper than any other ship canal in the world, and if in

future generations it should be necessary to increase the depth to 30 feet it can be done just as well after the canal is finished as it can be done now, or even cheaper, because then dredges could move easily through the whole length of the canal, and with this modern machinery dredge out the 30 feet required; but no one supposes the great ocean greyhounds which ply between Portsmouth, Liverpool, and New York are going to be in the trade of the Pacific. You find most of the vessels engaged now are 22 to 25 feet draft, very few that are more than 22 or 23 feet.

Mr. PATTERSON. And none more than 28 feet?

Mr. MILLER. None more than 25; and I do not know any of that kind.

Mr. BENNETT. When you say a depth of 28 feet, do you mean it will take a vessel, say, of 27 feet?

Mr. MILLER. Well, I suppose with 28 feet you would scarcely want to take a vessel of more than probably 26 feet draft, because as a vessel moves it draws down a little and it might touch bottom, but, mind you, a greater portion of this entire canal, so far as vessels are concerned, is without bottom. The river, except at points I have mentioned, is anywhere from 40 to 100 feet deep, and after you get out in the lake over the mud I have described then the lake is from 50 to 150 feet in depth, so that the minimum of 28 feet is only for a small part of the way. The bulk of it is of course entirely free, but the cost of getting a depth of 30 feet instead of 28 would be very slight after it was completed. Mind you, the mater sills of all locks are required to be 30 feet so there will be 30 feet in all locks, so you have simply to take up the bottom of the river and sand in the harbor to give you 30 feet the whole length if you want to, and why we should go on and add $10,000,000 to the cost of this or any other considerable sum to make 30 feet to start with, whereas the Suez started with a depth of 26 and the Manchester at 26 feet, I do not see the force of it.

On the west side from here down [illustrating on map] there is no necessity of taking up your time in regard to that. I will say here that the company presented two plans; one was to carry the water through here without a dam and the other with a dam. Here is a natural depression in the earth, called the Tola Basin, covering some 4,000 or 5,000 acres, which is 4 or 5 miles long, and where it opens out here it is narrow. One plan involved building a dam across that gap, thus making a large basin and saving excavations. The other was to carry the canal down through the basin in excavations, just as through any land, and not building any dam. Of course that dam can be safely put there, and it would not be as expensive as the excavation, and would give a large basin, in which vessels could lie at anchor there, or where they could pass each other without any trouble at all; but the Commission recommend, I believe, that a dam be not built, but that the canal be built by excavation.

That is a mere difference of detail, and it is a matter which is not worth while to stop to discuss one way or another. What they did, however, without giving it any consideration at all, is, they undertook to change the line of the canal here 4 or 5 miles from the right bank to the left bank of the Rio Grande, which would largely increase its cost, because it would necessitate a diverting of the Rio Grande and building a channel for it, which would be almost as expensive as the canal itself; and there is no possible good reason which can be given for it. It is clear country here, and no line has ever been so thoroughly investigated and surveyed as that is. Mind you, these surveys of ours follow largely in the line of the one made by Mr. Childs for Commodore Van-

derbilt, and two surveys made by the United States Government itself, and one partial survey made by the Nicaraguan Government, and they all came to the same conclusion.

I undertake to say that no work of this magnitude or anything like it has ever been so thoroughly prepared for the beginning of work as this has in advance. We have surveys as accurate as surveys of that kind can be made, and any necessity for delay for further investigation does not exist. Now, the Commission undertakes to say——

Mr. PATTERSON. Right in that connection. Now, there has been repeated surveys; is there a consensus of opinion, or rather is there a concurrence of opinion, among these surveyors in regard to the line?

Mr. MILLER. Substantially so. The original and old surveys undertook to follow the river there and make several dams, and to follow the river down through here [illustrating], but that was soon abandoned because of the amount of silt and deposits which came down, and it would have filled up and made the passage impossible to navigate.

Mr. PATTERSON. So the researches——

Mr. MILLER. Have all come to the same end, and there is nothing suggested by this Commission except minor details. As I stated to you this morning, they argue against the Ochoa dam, and end up by saying it is possible and it can be built.

Mr. PATTERSON. Did the Commission survey the route at all?

Mr. MILLER. The Commission spent from twelve to fourteen days on or near the line of the canal. They never made any surveys of any kind. They never even stopped at the sight of the Ochoa dam, and of course the Commission could not have made a survey. They could not make any survey that would be of the slightest use without two or three years' time with a corps of engineers.

Mr. PATTERSON. Tell me, now, could not any competent engineer here at Washington, with the data which was before that Commission, have as good an opportunity to arrive at a correct conclusion as they did?

Mr. MILLER. Certainly he could. There is no man who can go there and gain any knowledge except he gets a general idea of the country and material and he has an impression which goes with him and undoubtedly helps him to a certain extent, and no engineer would consider it necessary to go there except to verify; but assuming our surveys, so far as they go, are correct, any engineer anywhere in the world can take the plans and go over them and see whether they are feasible; of course, starting upon the premises as to what we have given him is true.

Mr. PATTERSON. They state the practicability of constructing a canal, but if I understand you they insist upon an increased cost growing out of the width of the canal and depth of the canal, and paying a much larger price for work and for wages than has been estimated by the company?

Mr. MILLER. That is what it amounts to. That is what their report says. I do not think they are fair enough to state their increased cost comes in that way, but that is an absolute and necessary inference, because it gives the increased quantities and then it takes an increased unit of price for doing the work, and of course the increased cost comes from those two elements.

Mr. PATTERSON. Have you made an estimate of the increased cost growing out of these various facts you have stated here in respect to the diverting of the canal and the dredging and wages, and the cost of removing material, and all that?

Mr. MILLER. I have not myself, but Mr. Menocal told me he had gone

over it, and the increased cost by increasing the quantities would be something like $10,000,000, and the increased cost of labor on their basis in addition.

Now, while on that point of cost, I want to call the attention of the committee to some reports here, a report made in the Senate in the last Congress by Senator Morgan, which gives first the report of our engineer of his estimate of the cost of this work in detail, the figures of which are stated, 20 cents per cubic yard for dredging, $1.50 for removal of rock above water, $5 for removal of rock under water, and $6 for concrete, etc. That estimate was made and reported to the company at the beginning, before I became connected with it. In my talk this morning, I stated the time that I became connected with this enterprise, but it is gone into here in great detail, and that estimate of Mr. Menocal amounted to $65,000,000. Now, the company, before proceeding further, took all this data, all these surveys, and all work that had been done by our engineers over three years' time, and submitted them to a board of leading engineers which was gathered in New York, at the head of which was Mr. John Bogart, a very distinguished engineer, who was for several years the engineer of the State of New York.

In New York we have an officer known as the State engineer and surveyor, who is elected by the people, the same as other officers. He is in charge of the whole canal system—Erie, Champlain, etc., and all those great works—and I know of no man more competent. With him were associated four other engineers, Mr. Myers, one of the leading railroad engineers of the South, who resides, I believe, in Richmond; Mr. Wellington, who was the editor of the Engineering News, a very distinguished engineer; Mr. Harvey, who was the engineer connected with the building of the first lock of the Sault Ste. Marie, and Mr. Hitchcock, an able engineer. These gentlemen took all of this data and spent a long time upon it and made a report to the company, and that is printed here, and I want to read just a few clauses from it to give you some idea. They begin by saying:

> We have carefully examined the unusually full maps, profiles, borings, samples of material, etc., which have been prepared and collected under the directions of your chief engineer, and the completeness and excellent form of which reflect credit upon your engineering staff.

I will not undertake to read the whole of it, although it is important. They go on further to say:

> The project as a whole appears to have comparatively few elements of doubt about it, as comparing it with other works of at all similar magnitude, and we consider it to be unquestionably feasible. The great area of Lake Nicaragua offers immunity from serious floods by regulating flow. Much of the earth excavation and dredging, the rock drilling, and the concrete mixing can be done by mechanical means, to that extent reducing the needs for manual labor. The dams and embankments are proposed to be made largely from the immense mass of otherwise useless rock spoil. Under the climatic conditions, as we understand them, an adequate supply of labor should be obtainable. The project in detail consists of the following elements:

Then they proceed to describe the line of the canal, which of course I will not read. As this document is accessible to the committee, I will not go further into it. They find the figures of our engineers to be substantially correct as to its estimates, but in addition to that they add 20 per cent to contingencies of construction as a factor for safety, and they carry the grand total of the estimate up to $87,799,570, and those are the figures which the company has acted upon instead of upon the preliminary report of Mr. Menocal.

Mr. PATTERSON. What was the estimate of the English engineer, to whom you referred?

Mr. MILLER. The estimate of the English engineer was within a million dollars of Mr. Menocal's estimate.

Now, one thing more in regard to the findings of the Commission or its criticisms. They claim we have not sufficient knowledge of the hydraulic conditions—that is to say, of the rainfall and of the floods and of the lake and of the river—and they say that more data should be obtained, and they recommend making careful observations for eighteen months. Now, the company have made careful observations for a much longer time than that, and these data are perfectly at their command, and have been published by the company. But let us see. The history of Nicaragua for a long time is well known in this country—certainly since 1849, when the California gold fever broke out and people began to go over it. We know from that time to the present there has never been any disastrous flood there, and from the nature of things it is almost impossible to have one there. In the first place, the rainfall upon the eastern side is very great, anyhow—nearly 300 inches a year, and it is difficult to imagine any greater rainfall than that—and that rainfall has done no injury to the works of the company, nor has it done any serious injury at any time to the river. The fact is, Lake Nicaragua is a great reservoir, which takes in the watersheds of the country and acts as a regulator. During the wet period the lake gradually rises, usually not more than 6 feet in the several months of rain. Then it gradually recedes again during the dry months, and the floods of the San Juan River are not sudden floods, such as we have here in this country.

A few weeks ago we had floods in the great rivers of Maine, the Androscoggin and Penobscot, which did damage of millions of dollars, which all happened in a day by the melting of snows; but no such thing happens in Nicaragua. Any examination of the San Juan River made by anyone will show you the high-water marks upon the banks and upon the trees. Everyone knows you can go along a river and tell what the high-water mark is. The rise of the San Juan River is from 4 to 6 feet. It is scarcely ever known to be more than that, and it has never done serious damage to the country at all. Mr. Menocal, chief engineer, in preparing the Ochoa dam flows, prepared wasteweirs to take the average flow of the river, assuming it to be 63,000 cubic feet per second, and he planned his wasteweirs to discharge double that amount of water, or 125,000 cubic feet per second. The Commission goes beyond that, and say it might at high flood discharge 150,000 cubic feet per second. That is a mere matter of detail. Of course we could build wasteweirs large enough to take off 200,000 feet of water per second, but it would cost several hundred thousand dollars more to do it; but we should find that out during the process of construction.

If we wait a year and a half before proceeding with this work in order to make these observations what value will they be? What was the condition of the Great Lakes last year, 3 or 4 feet lower than they were ever known to be in the last forty years! The St. Lawrence River last year was 3 feet below the lowest water it has ever known, and vessels were running on rocks which were never known to be in existence. Suppose the improvements of the harbors of the Great Lakes had been stopped or never commenced, because we had not sufficient data of the hydraulic conditions, and did not know what was the highest water or the lowest water? Last year we found harbors which formerly had 22 and 23 feet of water had only 18 or 19 feet of water in them. But I do not think anybody would argue that we ought to wait forever to find this out, but if you did you would have to take a period

running from twenty to fifty years, and then there would be no reasonable certainty about it.

As I stated here this morning, if the Ochoa dam went away it would not injure the construction part of this canal at all. It is possible to get rid of all the water here and wasteweirs can be made to pass 150,000 cubic feet per second, as the Commission say, or 200,000 or any other reasonable amount. But no such danger exists. But what could be learned in a year and a half would amount to nothing, and it is not nearly as much as we have now and the canal would be five or six years in process of construction before we would get the dam up and the wasteweirs, and we would know what the conditions were then anyhow and we would make provision for them. I do not think it neccessary to extendedly consider the question of rainfall. One of the things that has recommended this route to all engineers who have ever examined it has been its freedom from floods so different from the Panama route in connection with the Chagres River, from the fact of this great reservoir which gradually rises and gradually falls.

Mr. PATTERSON. I have heard it occasionally suggested, and seen it frequently in print, that probably earthquakes in that country would very seriously interfere with this enterprise.

Mr. MILLER. Yes; I understand a great railroad man said the records of a thousand years showed that no canal could be maintained there. I asked where the records were for a thousand years, but of course they could not be produced. Now, there has been no serious earthquake along the line of the canal within the knowledge of man, and the earthquakes that have been there in modern times have never damaged anything but the spires of churches. The motion of an earthquake at the surface of the earth is very slight. Of course, if you go up 100 or 200 feet in the air, at the top of a spire, it becomes important, but there have been no earthquakes in Nicaragua that would have damaged any works connected with the canal at all. Not only that, but the wells which are dug in the earth have not been destroyed or broken by earthquakes, and no change has been made in the San Juan River or any rivers there since we had any knowledge of the country or any history of it. I took down with me, when I went to Nicaragua, Major Dunton, who is one of the greatest seismic scientists in the world, and who, under the direction of the Government, spent four or five years in the Hawaiian Islands and elsewhere studying earthquakes and volcanoes, and he has made a very full report as to what he found, and it has been printed by the War Department. The whole question is there answered satisfactorily.

The damage done there by earthquakes has been nothing like that done in Charleston a few years ago, and other places in this country, and as the works of the canal are below or even with the surface of the earth no fear is entertained; but if it were feared that the locks might be injured by earthquake shocks, those locks could be built entirely of steel, as they are being built in New York and elsewhere, and it is not at all certain it could not be made cheaper to have the foundation of concrete and build the superstructure of steel, which could be prepared in this country and taken down there and set and in less time than it could be constructed of concrete. That is being considered by the engineers, but when the company suspended operation the engineers who had charge of it of course suspended their labors; but before the locks were built undoubtedly this plan would be considered, and then it would be submitted to a board of leading engineers to decide whether the locks should be built of concrete or steel con-

struction work and filled in with concrete or stone, so there is no danger from that under any circumstances. Now, I do not know that I care to say anything further in regard to the cost. There is one other thing which passed from my mind——

Mr. PATTERSON. In regard to the harbor at Brito, there are some difficulties there, are there not?

Mr. MILLER. At Brito the Commissioners of course recommend a change of that farther to the south. The report made by Mr. Menocal in regard to the winds will show that will be unwise. Brito was selected after several surveys had been made. In fact Colonel Child's survey ran in the same direction because the canal went down the north channel of the stream, which saved large excavations, and at Brito there was a small stream emptying into the Pacific, and there was a bar on which there was from 4 to 6 feet of water, and on the north side of this is a promontory of at least 100 feet high of solid rock running out into the ocean, and naturally we took this promontory as one of the breakwaters and built another breakwater parallel to it, a very natural place and a very easy place to build a harbor, and the breakwater is built out, and of course between this breakwater and this natural promontory a channel would be dredged, and the interior basin is of sufficient size to hold all the ships that would be necessary, and the answer to the report made by Engineer Menocal I think will satisfy every member of the committee there is no sufficient reason given for any change of that location, but if there were any good reason of course the board of consulting engineers would discover it and the change would be made.

Mr. PATTERSON. Are the engineering difficulties there as great as they are at Greytown?

Mr. MILLER. I should say not, from my own investigation of it, and I have been there. Of course, Greytown twenty-five or thirty years ago was a deep-water harbor. It is a natural harbor, but the bar closed and then gradually the harbor filled, so at last there is some 14 to 20 feet of water in some places and some places less. A portion of that harbor is going to be dredged out to a final depth of 30 feet.

Mr. PATTERSON. You have to excavate near the Pacific coast; you have to cut a dividing ridge or two, do you not?

Mr. MILLER. As we go out from the lake here, we go across the lowest piece of land there is in Nicaragua. The extreme height of that land here [illustrating] above water is 45 feet, and the average height above water is 20 feet, so you have to make an excavation of 20 feet on an average, and then 30 feet below to get the depth of water in the canal. This work has been most thoroughly and carefully surveyed, because that is occupied mainly with farms and not difficult to get at at all.

I may say one more word in regard to the Commission increasing the size of the prism of the canal on the river from 125 to 250, and on the lake from 150 to 300 feet. They may have had in mind that as many ships were to pass through this canal every year as through Saulte Ste. Marie and therefore the canal has to be made so wide, but what are the facts? Last year there passed through the Saulte Canal vessels to the number of something like 17,000, being something over 70 a day, nearly 75 during the 230 days that it is open. Suppose the Nicarauga Canal carried 6,000,000 tons per annum only. Ordinary vessels navigating the sea which would pass through it would only take 11 vessels a day passing through the canal to carry that amount of tonnage, and it goes without saying that the capacity of passing in this broad basin here and the

San Francisco Basin and in the main river and in the lake and Tola basin, that there is only a small portion of the canal in which vessels could not pass freely, but large seagoing vessels pass to-day without any interruption in the Manchester Ship Canal, the bottom of which is only 125 feet.

So, is there any reason why they could not pass just as well in the Nicaragua waters as in the English waters? I see none at all, and the small number of vessels which necessarily pass through any canal of this kind in a year makes it possible, if there should be any difficulty in the bends of the river in passing freely, to hold ships by means of the telegraph, and one vessel would not be allowed to go into a narrow channel until another had gotten out of it. There would be no difficulty about that at all with the small number of vessels passing through the Suez Canal last year, in which 3,600 or 3,700 vessels passed. That is somewhere from 11 to 12 or 13 vessels a day. The necessities of a canal of this kind do not demand any such width, and there ought not to be any such waste of money, but this Commission seems to have gone on the idea that this canal should be begun on the most expensive scale, as regards width, depth, etc.

Mr. PATTERSON. I understand after you get out of the basin at Greytown and get to the foothills, from there to the Pacific Ocean you have a salubrious climate—it is a rather healthful country—and there would be less likelihood of any people engaged in labor dying and being sick than at Greytown?

Mr. MILLER. The conditions are these and the records show it. At Greytown there is never a day in the year in which the trade winds do not blow, in which the winds blow from the ocean on to the land. The result is, while this low land would naturally create miasma and fever and does to a certain extent, these constantly blowing winds make it substantially healthy. As I told you, there were for six months 1,600 Jamaica negroes working upon this line of railroad, 11 miles long. Only four of them died there of any disease; others were killed by accident. The moment you approach the foothills and mountains the rain decreases. When you come to the lake, we have a record from Dr. Hall, who lives at Rivas, 5 miles from the line of the canal, who has resided there for thirty or forty years. I know him well. He has kept a record of the rainfall of all that region, which shows an average fall of 65 inches annually. Of course, no tropical country is a sanitarium, but I went through that country in the month of March and part of April with a party of thirty gentlemen. Some of them were over 60 years of age and others down to 20 years of age, none of whom were familiar with the tropics or had been in them. We tramped through this wilderness and slept in open sheds at night and waded swamps and drank the water of the country. Not one of the thirty was sick at all during the entire journey or during the time we were there.

We have had American engineers who have been three years continuously in Nicaragua without ever being sick or going to the hospital. Other engineers have been sick for a short time, but the records of the hospital—and I believe the subcommittee have had Dr. Stubbert before them, who was chief surgeon and in charge of this business all the time the company was carrying on work, and here is a short sketch from the hospital if it will not detain the committee too long. Here is one year's work. Number of patients in the hospital December 31, 1890, 25; admitted during the year 507, total number of patients 532; discharged cured 339, discharged improved 112; unimproved 8; died 10. In the hospital December 31, 1891, 63, and of the deaths, 4 were the results of

accidents suffered while at work, 1 from syphilis, and 5 were from climatic ailments. This was less than 1 per cent, or accurately speaking 0.93 of 1 per cent. Total death rate for the year was 0.187 per cent including those who died by accident. I do not believe any great public work in the United States can show any better record.

Mr. PATTERSON. What about the Chagres fever which prevails at Panama?

Mr. MILLER. No such fever has been known at Nicaragua, and there is no record in modern times of a single case of yellow fever even at Greytown. During our work there came a steamer there from Colon bringing up a portion of this dredging plant which we bought. When it left Colon it had Chagres fever. Some four or five of its crew were put in the hospital at Colon and the vessel came on to Greytown. When it arrived there it had six or eight men down with Chagres fever, and they were taken out and put into our hospital and treated, and none of our men took the disease; and every one of those men who went into the hospital was cured and came out, and every one who went into the hospital at Colon died. That is the only record we have of that matter.

Mr. PATTERSON. This is a very interesting discussion, and I make these suggestions so as to get the important facts into the record?

Mr. MILLER. I am very glad to have you make them.

Mr. PATTERSON. My information is that at Panama, both on the Atlantic and Pacific sides, there is a dead calm, and trade winds are unknown there, whereas at Greytown and Brito, on the Caribbean Sea and the Pacific, the trade winds prevail, and if this canal is constructed the sailors can sail through this canal without difficulty, whereas if the canal was constructed at Panama, even if it was possible to construct one there, it would be only useful for steam-going vessels, for the reason that there is a dead calm on both sides at that point?

Mr. MILLER. I am very sorry that I have not got a large map of Central America and the upper part of South America; if I had I would show you that Panama lies in a great bend or bay. The facts are that the winds do not reach it, and trade winds do not prevail there, and that is undoubtedly the reason why the fever is there, as it is not blown away. This country through here [illustrating] is the lowest piece of land there is in Central America. The trade winds blow in there every day in the year and dissipate the fevers and pass through the highlands. When we come to the Pacific side, the wind blows in here, and right here at San Juan del Sur is the summer resort for people of Nicaragua who come there for health, and who live there during the hot season, showing it is the healthiest place there.

Now, as to the possibility of sail vessels using this canal and not using the Panama, if it was built, Lieutenant Maury, who is a great authority upon the geography of the seas and winds connected with it, has written upon this subject, and a gentleman who has been writing against the canal and who has given as one of the chief reasons why it should not be built because it could never be used by sailing vessels, has quoted Lieutenant Maury upon this question, and I want to show you how he has been quoted. This is a quotation made from Lieutenant Maury. He says: "Should nature by one of her convulsions rend the American continent in twain and make a channel across the Isthmus of Panama or Darien as deep, as wide, and as free as the straits of Dover, it would never become a commercial thoroughfare for sailing vessels, saving the outward bound or those which could reach it with leading winds." Now, Lieutenant Maury wrote that, but the gentleman quoting this against the canal did not quote it all. Let us see what Lieutenant

Maury further says in this same article. He says: "We come now to the Nicaragua route. It is to this part of the Isthmus that we must look for a route that shall best fulfill the requirements of commerce. Vessels under canvas would, in the main, do the fetching and carrying for the Nicaragua route, which, for reasons already stated, they can not do for Panama. The aggregate amount of this trade is immense, and it is neither accommodated for Panama nor Panama for it." (Sullivan's report to the Navy Department, 1883, p. 148.)

This is the main argument made against the canal. Now, in regard to this question, I would be very glad to have the committee call some distinguished officers—for instance, Admiral Ammen, who is 80 years old, but is a man who knows more about the subject than all the rest of us and understands this question thoroughly, or Captain Taylor, who is at the head of the War and Navy College at Providence, R. I., who has written very much upon this question and who knows it thoroughly, or any of your naval officers who are familiar with this. I do not want to talk to you about the sailing qualities of this route, because I am not a sailor, and I take my views very much from the statements of Admiral Ammen and Captain Taylor and others; but there is another point while I am about it, and that is the Commission questions the surveys of the river and lake. Now, these surveys were not made by our company; they were made by the United States Government, under Commander Luce, and the lieutenant in charge of the survey was a lieutenant named J. W. Miller, now retired from the Navy and president of one of the leading steamship lines running from New York up the coast to Providence and elsewhere. He personally made this survey during the years 1872–73, and spent a long time there.

I would like to have this committee call Lieutenant Miller, to gain from him the fact whether these surveys were made carefully and whether they are reliable. They were made by a naval officer, under the direction of the United States Government, and they were not made in the interests of any company, or any concession, or anything else, because there was none in existence. They were made carefully, as honestly, and as fairly as officers of the Navy could make them, and we claim they are sufficient for all preliminary work of beginning this canal and going on with it. The whole survey of this lake has not been made to obtain its depth everywhere, but we have obtained the depth along the sailing channel, and of course the Government eventually, or some other authority, or the Nicaraguan Government, will undoubtedly make a complete survey of the lake and take soundings all over it, so you will have a chart to know where to anchor your ships; but I submit that that is not necessary at the beginning. I think it is sufficient to know the depth along the sailing line.

Mr. PATTERSON. You know it will float all the navies of the world?

Mr. MILLER. Yes, sir; I know that, but the Commission wants this thing delayed eighteen months and wants $350,000 appropriated by the United States Government to send out a commission of engineers to make these surveys during the eighteen months. Well, $350,000 would put quite an army of engineers in Nicaragua and keep them for eighteen months, but we submit that when they get through they would not have anything we have not got that would be of the slightest value. Of course it would delay this great enterprise for that length of time.

I have talked so much about this thing all over the United States that I never know when to stop. Now, I would like the committee to ask me any questions that have suggested themselves to them during my talk.

Mr. PATTERSON. There is just one point which, in the beginning of

your discussion, you did not explain fully. My understanding is that when these concessions were granted by Nicaragua and Costa Rica the arrangement was that Nicaragua was to have $6,000,000 of stock and be represented by one director, and Costa Rica was to have $1,500,000 of stock and be represented by one director?

Mr. MILLER. That is correct; that is the agreement.

Mr. PATTERSON. Now, what is the extent of the right of way, what is the width of the ownership of the canal?

Mr. MILLER. Well, the concession carries with it a gift of something over a million acres of land. In the first place we are permitted to take all the land that we want for the right of way, be it more or less, that is through the public lands, but upon the western side the Government was to furnish us with the right of way by our paying them $50,000 in gold, which we paid them, and then they were to proceed to condemn the right of way for us. I think it is not all condemned, but we paid the Nicaraguan Government $50,000 in cash and they have condemned a portion of it. The Government is to furnish the right of way, free of course, over the public lands, and we take all we want, and in addition to that we have a right to go upon the public lands and take timber and stone and help ourselves to anything we can find, and then after the canal is completed we are to have a million acres of land lying upon the line of the canal, in alternate sections, the Government holding one and the company the next.

Mr. PATTERSON. Then, if I understand you correctly, the Maritime Canal Company owns these concessions?

Mr. MILLER. Yes, sir.

Mr. PATTERSON. And the present owners of the canal company, or rather the stockholders of this construction company, have expended something over $4,000,000 in acquiring these concessions and in the work that has already been accomplished on the canal?

Mr. MILLER. That is correct.

Mr. PATTERSON. And the canal company now controls practically the entire stock, amounting to $92,500,000, and it owes to its stockholders the amount expended on the work?

Mr. MILLER. It owes this amount of money to its stockholders. It has not any debts outside at all.

Mr. PATTERSON. I mean, if it were to pay the stockholders this amount of money, and they were willing to give it up, it would then have stock amounting to $92,500,000.

Mr. MILLER. Yes; that is substantially correct as it is.

Mr. SHERMAN. Was there some provision in these concessions which made them nonassignable?

Mr. MILLER. They can not be assigned to any Government, but there is nothing in the concessions forbidding their being assigned from one company to another company, or there is nothing in the concession to prevent any Government holding stock in them. We are bound to hold the lists open and let anybody subscribe, but the Government of Nicaragua should have $6,000,000 and Costa Rica $1,500,000 of stock, and then the United States or any other Government could come and buy stock. There is no limit or control upon that whatever, but we could not sell this out to any Government. Therefore, the necessity of the Government building this canal through the medium of a company with its own charter.

Mr. DOOLITTLE. I would ask you to have something to say about the probable commerce passing through this canal. There have been some recent publications relative to that?

Mr. MILLER. Yes; there have been some publications relative to that, trying to show it would not do any business; yet at the same time there have been publications emanating from the transcontinental railroads opposing the canal upon the supposed ground that it would take the business away from the railroads. Just how the two things come together I do not understand, although these arguments are made by the same party. Now, as to the probable commerce of this, at this late hour I will not undertake to go into that in a very full and elaborate manner, but I want to call the attention of the committee to this report made to the Senate last year, and there you will find the views of the company set forth in full, with an article prepared by our secretary, Mr. Atkins, which is printed here in full.

Mr. SHERMAN. What page is it?

Mr. MILLER. It commences on page 175. You will find it a very thorough and carefully prepared article. I will do nothing more than call your attention to the results. Now, in the first place, the Congress which met in Paris in 1879, over which Mr. De Lesseps presided, and to which conference our Government sent Admiral Ammen and Engineer Menocal as delegates, was composed of leading engineers of Europe, and found that the canal at that time would have something like 5,000,000 or 6,000,000 tons of freight to begin with. That was in 1879. This report made here takes from the British Board of Trade the actual commerce of the world, and it divides it into that portion which would be entirely tributary to the canal and that which would be liable to be influenced to the canal and drawn toward it, and it is accurate as to the commerce which exists; of course, no one can undertake to say whether it will all go through the canal.

The only thing we can say is that commerce seeks the shortest line and cheapest route, and it is fair to infer that the commerce of the world which wants to pass from the Pacific Ocean to the Atlantic, and vice versa, and the cheapest—which can be accomplished in the least time—and I will from the Atlantic to the Pacific, will take the line which is the shortest simply refer you to this; but I simply call attention to what it shows. It shows, in the first place, the class which is entirely tributary to the canal—that is to say, which would pass through the canal if it sought the shortest and cheapest route—amounts to 5,332,415 tons. The second class, which is largely tributary to it, that might go through it but would not find as much profit in going through as the other class, amounts to 2,526,542 tons. Then comes the third class of tonnage, partially, and only partially, tributary to it—such tonnage as upon the west coast of South America, we will say in the lower part of Chile, down that way, which might go around Cape Horn or might come through the canal, depending upon which would be the cheaper. This is only small, amounting to 262,136 tons, making a total of 8,122,093 tons.

Now, that takes no account whatever of the growth of commerce by the construction of the canal; and let me say here that these figures correspond substantially with the estimates made by the French engineers at the conference in 1879, adding the annual growth of commerce from that time to this, and it makes substantially the same figures as ours. But if there was not but a million tons to-day in sight that would probably go through the canal, I undertake to say, judging from the past, that within ten years' time from the construction of the canal it would have a commerce of more than 10,000,000 tons. When the Suez Canal was opened at first it seemed to be an absolute failure; commerce still continued to go around the southern point of Africa. But from year to year it began to gain, until to-day it (a gentleman gave me a

pamphlet here to-day showing the last report)—well, it does not matter as to getting it exactly, but the returns there are from 8,000,000 to 12,000,000 and 13,000,000 tons per year, and the receipts are, I remember, given in this last report, $15,000,000; and after paying for all betterments and all commissions which they are compelled to pay under their concessions and under their rights, it left a dividend upon their stock of 18 per cent. It has frequently paid 20 per cent, and the stock has been as high as 750 in Paris; and I only speak of this to show you how commerce grows when you open a new, desirable, and cheap way.

In the Sault Ste. Marie Canal, before the Government built the present lock, there was a private lock there. The largest amount of commerce passing through that, I believe, was about 500,000 tons. The Government built a lock—a very large lock—sufficient to carry several vessels at a time; and what has been the result? The Sault Ste. Marie Canal passed last year, I think, over 17,000 craft of different kinds and something like 12,000,000 to 15,000,000 tons of freight. That has all been created since the lock was built. People did not go into the region about Duluth until there was means of transportation, and when it came they went into the country and opened up the mines and iron ore and milling business and wheat business, and the result has been the stupendous amount of material which passed through the Sault.

Mr. DOOLITTLE. And there the waters are closed during the winter time?

Mr. MILLER. Yes, it only runs from 225 to 230 days in the year. Now, what is the position of the Pacific Coast? We have a vast territory reaching from Mexico to British Columbia. It has the finest climate in America, and it has the most fertile land. The State of Washington or the State of Oregon will produce all the wheat, if it is cultivated, that this country requires for our whole 70,000,000 people. It is estimated that the Pacific Coast alone is capable of maintaining a population of more than 100,000,000, but it has less population than the cities of New York and Brooklyn combined, and why? Simply because the material which it produces is raw material, and it must have a cheap and quick outlet to the markets, and it is farther from the markets of the world to-day than any other civilized portion of the globe. It is 14,500 miles from San Francisco to New York by water, and the same distance, or a little more, to Liverpool, whereas India and Argentina get their wheat into the Liverpool market in less than a quarter of the time it takes from San Francisco around Cape Horn, and the result has been what? The country is left vacant, our people do not go there. They take up less fertile and colder and less desirable lands.

If that canal were opened, the raw products could be carried to the markets of the world at rates which would leave a fair margin of profit to the producer. If it is done, they would be able to compete with Argentina, India, and Russia. Unless it is done, the export of wheat from the Pacific Coast will substantially cease within five years, because there is no profit in it, and it is growing less and less because Argentina is being developed. Only a few days ago I was talking to the secretary of our legation at Argentina, who had returned on a visit home, and who gave me an account of the railroads and opening up of that country and developing of the growth of wheat, which all goes to prove this work must be done and done speedily if the Pacific Coast is to be developed. Now, the lumber and timber standing in the States of Oregon and Washington, if increased 25 cents in value per thousand, would more than pay the cost of building this canal twice over. Within ten years the Atlantic Coast must have this timber. As everyone

knows, the great bulk of the white pine of Michigan, Wisconsin, and Minnesota is disappearing. Ten years from now will see it all absolutely used up and it will not be able to supply the demand at all.

Some two or three years ago several ships laden with spars, the finest in the world for shipbuilding, went from Puget Sound around Cape Horn to Maine and went into ships building in Maine. The shipbuilding timber of Maine and all the Eastern coast is disappearing, and if the canal were built to carry the raw material, which can not be carried by railroads successfully, it would at once attract a large population to that country. I have no doubt it would double within five years. The railroads who are fighting this enterprise, and believe it would ruin them, I think would be greatly benefited by it, because the business of the transcontinental roads, their through business, has never been any considerable return to them—less than 10 per cent; but put 5,000,000 of people upon the Pacific Coast and the local business, the short haul of the railroads of the Pacific Coast, will be quadrupled, and the profits of these roads will be something enormous. I refer the committee to this printed report here for exact data. I am speaking now entirely upon what I believe will be the result, and as to the exact data I prefer to have the committee take the report made by the company which is, in our judgment, correct.

The CHAIRMAN. What do you estimate the receipts of the canal, say, a year after its completion?

Mr. MILLER. Well, we believe at the opening of the canal that out of this 5,000,000 or 6,000,000 tons of freight, which is tributary to it, and which ought to go through it, that from a half to two-thirds would go through it at once. We have no doubt of that at all. And in the statement which I made to the committee of the Senate when they changed the bill and substantially took control—took ten directors and took two-thirds or three-fourths of the stock—I based the results upon these figures. Say, 4,000,000 tons, at $1.50 a ton toll—and I assume the tolls will not be higher than that—although the Suez Canal when it started had a toll of $2.50 a ton, and it is now $1.85 or $1.87; but 4,000,000 tons, at $1.50 a ton, would be a great inducement for freight to come that way, and that would give us $6,000,000 on 4,000,000 tons.

If the Government were to guarantee or issue $100,000,000 bonds at 3 per cent, the result would be as this: The interest would be $3,000,000; the operating and maintenance of the canal will be $1,000,000. We are sure that is quite safe, and we think more than safe, but we will call it $1,000,000. That brings it up to $4,000,000. Then $1,000,000 put in a sinking fund for sixty years—the bonds to be sixty years in length—and $1,000,000 per annum added to the sinking fund will at the expiration of sixty years have paid off the entire debt. One million dollars then should be put in the sinking fund, and that would be $5,000,000, and that would have to be paid before anything came to the stock at all. Then, if I am correct in supposing 4,000,000 tons might pass, there would be $1,000,000 left for dividends upon the stock, or if not, even if it were to take two or three years to arrive at that it would not be entirely out of keeping of great enterprises of this kind, which require time.

Now, as to sailing vessels passing through it, it has been held, I understand, that sailing vessels can not pass through it; but that is a mistake, as I have shown you, as you will find from officers of the Navy if you call them, and I am frank to say this, that one of the first and most important results of this canal would be the abandonment of the building of more sailing vessels for that trade which is now carried

around Cape Horn. Sail vessels will not be built at all. The vessels will be what the German and English build, called tramp steamers, or trade carriers with a low consumption of coal, making from 7 to 10 knots an hour, thus making the trip within a reasonable length of time.

Mr. Scott, manager of the great Union Iron Works of San Francisco, stated to me the last time I was there that when this canal was built there were not half shipyards enough in the United States to build steamers required for this trade, and undoubtedly the business would change into this class of steam carriers, just as it has done in the Suez Canal. In that canal when it began there were quite a large number of sailing vessels which went through, but no more were built. Steamers came in their place, and last year I think only one sailing vessel went through the Suez Canal. There may have been two or three, but my memory is not precise upon that question; but certainly not more than three, four, or five sailing vessels went through. The whole business has been transferred to the steamers, and that is one of the advantages, because it reduces the time, and the cost of commerce is time as well as in anything else; because it necessitates insurance during the time the produce is afloat.

Mr. DOOLITTLE. I want to ask you what difference that would make in marine insurance, if you have investigated that at all, as between going through this canal and around the Horn?

Mr. MILLER. Well, you can not insure a vessel to go around the Horn unless it is first-class; there is no marine insurance company which will take it.

Mr. BENNETT. That is in consequence of the danger?

Mr. MILLER. In consequence of the danger. Let me read you a few words from Capt. William M. Merry, of San Francisco, who has been for many years a navigator around Cape Horn. Captain Merry says:

> The difficulties of the Cape Horn route Mr. Nimmo lightly dismisses as of no consequence, as he may safely do at Huntington, Long Island. When I recall the terrific gales, the heavy seas, the sleet, snow, and ice encountered during the eleven voyages I made around the Cape, I can realize the contempt due such a perversion of the truth. No vessel is insurable at usual rates by marine underwriters for the Cape Horn voyage unless she rates first-class, and the class of ships rounding Cape Horn is the largest and finest in the world. As they approach the Cape they are stripped of all light yards and sails; prepared for a severe contest with the elements, which they seldom escape. The marine annals of San Francisco are a lifelong record of disasters off Cape Horn, and occasionally an able ship, tired of the contest, with crew worn-out, spars and sails blown away, squares off away for the Cape of Good Hope, to reach San Francisco by a route fully one-third longer, and tempestuous at that.

Mr. CORLISS. I desire to ask what the present owners are to accept under this plan, $7,000,000 of stock?

Mr. MILLER. There is no plan at all, sir.

Mr. CORLISS. Well, it has been before us.

Mr. MILLER. What I stated here this morning, the answer I gave to the Senate committee—you perhaps were not in at the time, but I will repeat it—we were asked by the Senate committee several years ago upon what terms we would allow the United States Government to come in and control this enterprise through the company, and after consultation with the leading directors and stockholders I made this statement, that the Government might take the company, taking two-thirds of its directors, to be appointed by the President, and taking two-thirds or three-fourths of the stock in the Treasury of the United States, taking absolute control of it if they would return to us the amount of money that we had expended upon it, which we stated to be in round figures about $4,500,000, and that in addition to that they

should give us of the stock of the maritime company whatever they thought we were entitled to for our services, for our energy, and time in holding this thing and risks we had taken in it, and that we would submit ourselves to the justice of Congress upon that question as to what it should be.

As to the amount of money that we had expended, we would submit that to a commission to be appointed in any way that might be agreed, only that one of our company might be there to see justice was done, and one to be appointed by the President, and if those two did not agree, why those two should select the third, and that whatever they found we had actually expended should be returned to us in cash or its equivalent in bonds. That proposition was made to the committee, and that is the only proposition we have made; and as to the expenditures, we have preserved all of the books of the company and all the vouchers and all the files of all kinds and of every name and nature, and we can show to the commission or to a committee or to anybody everything that we have expended and what it was expended for.

It is unnecessary, it seems to me, that this committee, or any committee in Congress, should go into the details of that, because it would be endless, as it would include five years of work and thousands of vouchers and thousands of items, but they are all there and can be shown. We should, of course, expect to be paid for all moneys we have expended in what might be called promoting the work. That is to say, I have spent three years of time in going to different parts of the world speaking upon this and writing upon it, but the promotion work has been comparatively small, comparatively a few thousand dollars in comparison with the work we have done; but that was necessary to bring the enterprise before the world and have them understand it. We, fortunately, have never expended any money in Washington except our own traveling expenses, and that has been charged up, and the expenses of our own attorneys in New York who have come down here to express to the committee just the legal condition of affairs. We have not any $2,000,000 or $3,000,000 to account for as expended in legislative work; we have not done anything of the kind. We have not had it to expend, and would not have spent it if we had had it.

All of our accounts will be open if it is done, and I want to simply say this, and I want to repeat what I said this morning: As the matter stands now we are prevented from getting any money or doing anything with it, and of course we may be compelled—gentlemen who have put their time and money into this thing—to lose it all; but if we do that we shall do it without complaint, for I say for myself I have never been engaged in a work that was likely to be of so much benefit to the whole world, particularly to my own country, as this, but we feel now that in some means or in some way Congress ought to say, "We will take this work off your hands upon the terms proposed," or "We do not want it at all," and then give us a clear field, and if we can not make anything out of it and get the money outside we will simply retire beaten and let some others undertake it. That is the way we feel about it. I am not finding any fault with Congress at all. I have been here myself as a member of both Houses, and I know the difficulty of doing a great work of this kind, and I know there are a great many men in Congress who honestly believe the Government ought not to have anything to do with it, that it is an outside affair, and it is all wrong and should not be touched, and I appreciate all that, and I know they are honest in that, although I do not agree with them myself, but we understand all that difficulty and have no fault to find at all.

The gentlemen, particularly in the Senate, who have been working on this for years, making it you might say a hobby, attempting to get it through, have treated us with all fairness and we have no complaint to make, and so far as the House is concerned this is the first time I ever appeared before any committee having anything to do with the question, and we have no complaint to make here in any way, shape, or manner, but we do feel we have the right now to ask that we know whether the Government is going to take the work and carry it through to success or else that the Government shall in some way indicate to the world at large its decision not to have anything to do with it because it does not think it wise, or ought not to be done by our Government, and leave us free to go over the world and get what money we can get to carry on this work. We certainly shall never give it up until our concessions shall expire, and we hope in some way to carry it to success.

Mr. SHERMAN. How long do your concessions run?

Mr. MILLER. Our concessions were for ten years, and three years remain, and then we have the right to ten years additional, making twenty years in all, which makes thirteen years in which we have yet to complete the work.

Mr. CORLISS. Are any of the terms of the concessions such as would compel the paying of a revenue to Nicaragua and Costa Rica?

Mr. MILLER. Not unless they get dividends on the stock. They stand like any other stockholder. Nicaragua has $6,000,000 of stock and Costa Rica $1,500,000 stock, and if dividends are made of course they would get their pro rata.

Mr. CORLISS. But there is nothing to prevent their being paid off and the United States having a majority of the stock simply charge nothing for maintenance?

Mr. MILLER. Of course the United States can from the beginning, if they saw fit, pay interest on the bonds and make the canal free at any time, or make the tolls a dollar to begin with, or a half dollar, or anything it likes. If they control the business they can do that, and I presume the Government, after getting revenue sufficient to pay interest on the bonds, would probably reduce the tolls materially, and that of course is one reason why the stock we might get as compensation for our services would be worth very little, because it would depend entirely upon whether the Government is going to reduce the tolls, but it is fair to assume the Government is going to treat us properly and would not reduce the tolls to where nothing would be paid upon the stock, because if it did it would not be justified as far as Nicaragua and Costa Rica are concerned. It would, in justice to them, have to compensate them and pay them 5 or 6 per cent dividend on their stock. I assume it would not do anything else and would not treat Nicaragua and Costa Rica in that way, and it probably would not treat its own citizens any worse than it did them. At all events we would rest our case there.

Mr. SHERMAN. I understand the proposed tolls are $1.50 a ton?

Mr. MILLER. Of course no action has ever been had upon that. Originally, when it was first started, it was assumed $2.50 a ton, because Suez charged that at first, but there was so much business it found it profitable to reduce the tolls to $1.85 a ton, and I have not any doubt at all but what this company would start its tolls at $1.50 a ton. That would be my judgment and desire, and if I was in control at the time I would have something to say about it.

Mr. SHERMAN. The probable tonnage would unquestionably yield a sufficient revenue to pay the interest upon these bonds and also provide a sinking fund for them?

Mr. MILLER. We have no doubt about that at all. If I had as much money as some one or two men in this country have I would build the canal out of my annual revenues. There are half a dozen men who could build it out of their annual revenues and have the best canal in the world, but the difficulty now among our American people is just what I have expressed; that is, people say the Government ought to control it, and therefore the Government ought to pay for it, but we can not do anything until Congress has decided to take it, or decided they will not have anything to do with it; and if Congress decides that, I shall make a vigorous appeal to the people of America to get the money to enable us to make it a success, and if that fails I will retire and let somebody else take it up after me.

Mr. WANGER. Did I understand you to say that what you call the promoting expenses had been charged up?

Mr. MILLER. They are a part of the expenses; for instance, my expenses of traveling over the country and publishing pamphlets and things of that kind. We have not paid the press of this country anything, and I am frank to say the press of this country have published articles regarding it; in fact, they have come to us and asked them and printed them, and there is no expense attending the press of this country except the mere notices of our annual meetings, that is all, which we paid for as any other amount due; otherwise the American press have given us hundreds of thousands of dollars worth of advertisement, which would have been charged for ordinarily, in so far as arguments in favor of the canal are concerned. That has been so all over the country and we have to acknowledge that.

Mr. SHERMAN. I understand the percentage of the whole expense is very trifling?

Mr. MILLER. It is a very small percentage of the total—probably it might be 5 per cent. It is what has been done in every enterprise, railroad or otherwise, and is a legitimate charge.

Mr. ELLETT. I would like to know wheth · the terms of the Mahon bill—I have not been here during all of your speech—are objectionable?

Mr. MILLER. I have not read the bill at all, or looked at it. I simply stated what our proposition was to the Government. Any bill which carries that out, why, we will undoubtedly accept, but I have never read any portion of the other and do not care to.

Thereupon the committee went into executive session.

WASHINGTON, D. C., *Tuesday, April 1, 1896.*

The committee, having under consideration the Nicaragua Canal, met at 11 a. m., Hon. William P. Hepburn, chairman.

STATEMENT OF CAPT. H. C. TAYLOR, OF NEWPORT, R. I., PRESIDENT OF THE NAVAL WAR COLLEGE.

The CHAIRMAN. There are three propositions up here upon which we wish more particularly to get information. One is the practicability of the Nicaragua Canal; another is the probable accuracy of the estimates made by the company; and the third is the probable use of the canal, as measured by the tonnage.

Mr. DOOLITTLE. I would like to add that we expected to have Professor Menocal before the committee this morning, and I have received a note from the Acting Secretary saying that Professor Menocal would

be unable to appear to-day; but he has submitted a paper which goes over the surveys, and answers completely all the objections and criticisms offered by the recent Commission, consisting of Engineer Ludlow and others, who visited the canal. We have the letters of other experts in this statement made by Professor Menocal. Professor Menocal states that he hopes to be here within a week from this time to answer such questions as the members of the committee may desire to ask him.

The CHAIRMAN. I do not wish to dictate the line of Captain Taylor's speech, but I suggested such facts as perhaps the members of the committee desire to hear.

Mr. WANGER. I would like to have Captain Taylor tell us all of the facts within his personal observation.

Captain TAYLOR. As to the practicability of the canal, as has been stated by Mr. Doolittle, Mr. Menocal has a reply, of which I knew before I came here, and which I believe to be very full. I have never taken that part in this enterprise which would enable me to give you any remarks as regards the engineering details. I was for many years engaged, with the consent of the Government, being on leave from the Navy Department, in promoting the enterprise in New York, and I became, in 1885 or 1886, vice-president and general manager of the company, and continued this service until the time came for me to again take a ship, when I resigned and went to China in command of a vessel. On returning, I found that, owing to the general depression in business, the enterprise was flagging. I have given great attention to what you might call the general aspects of the enterprise.

The chairman first mentioned the question of practicability. This question will be answered by the paper of Mr. Menocal. Its practicability has been conceded since 1869 continuously, and it was discussed before that from the days of Cortez; but since 1869 it has been discussed practically, and whenever a doubt has arisen as to the location, the Government has sent surveying parties there. As to the matter of cost, I think you can say that everybody may be right in the opinions expressed upon the subject. It is possible, if we wished to do so, to spend $120,000,000 or $130,000,000 in building that canal. Under certain circumstances that much could be spent; but under judicious and wise management the figures that we had from parties not personally interested in the canal would make it cost not above $85,000,000. The company estimated that it could be built for $65,000,000, but they chose to put that figure up in order to take the verdict of those who were nonpartisan. At the same time many persons who are not otherwise concerned in it, such as contractors and others, as well as Captain Webb, the veteran shipbuilder, who as long ago as 1850 became interested in the Nicaragua Canal, said that they would be glad to take the contract and make a profit out of it at $45,000,000 to $50,000,000. I make these statements to show the range of opinion upon the question of cost. If you were to build double locks, if you would widen the rock cut from 80 to 120 feet, and much else of the same sort, then you might run the cost up to $90,000,000.

The chairman mentioned something about the probability of the work being done and completed on the estimates. That is also covered by what I have stated. In reference to the use of the canal, it is a thing to which I have given a good deal of attention and thought. Its use will be both national and international. It will be, as we believe, a great factor in getting our flag flying upon deep-water ships, and in taking an intervening step, as it were, to deep-sea commerce by first

establishing a coastwise commerce in deep-sea ships. In other words, ships which clear from New York or New Orleans for Puget Sound or San Francisco will be, you may say, coastwise commerce, and yet they will go through that canal, and in order to reach it will require to be deep-sea ships. By such means it is hoped that we will see a new birth of American shipping on the high seas.

In looking at the map, it appears among other things that the nation occupying the North American Continent should naturally be the one to carry all the commerce that passes between Asia and Europe by way of the Atlantic and Pacific oceans. In order to show the shortest route across the North Pacific between our coast and Yokahama and Hongkong, an accurate chart of distances is necessary. The rectangular or Mercator's projection is familiar in maps of every-day use, but it fails in that it shows the shortest distance as apparently curved. I think we all recognize that as true, and that we must go up to the northern latitudes in order to get the shortest distances. Nevertheless, I find that many shipowners, men who have been engaged in shipping all their lives, do not fully realize that idea, because the graphic representation of distances across the sea has not been properly presented to them. Concerning the business of the Nicaragua Canal and the trade thence to China and Japan, the commercial world is much deceived, because it has not that proper graphic representation of great circle routes.

I will send your committee to-morrow some charts published by the Government, which show by means of the gnomonic projection the shortest distance as a straight line. It indicates also in a general way the commerce which will go through the Nicaragua Canal in future. It has been claimed by opponents of the canal that vessels from the canal passing across the Pacific to China and Japan would pass at once toward Honolulu and away from our Pacific coast, leaving our Pacific cities far away from the line of sea trade. Indeed, when I arrived from China at San Francisco some years ago, I found that placards had been posted in various public places, saying that if the Nicaragua Canal were built the trade would be diverted from the Pacific coast, and the grass would be growing in the streets of San Francisco a few years after the canal was completed.

This statement is absolutely contrary to the facts of the case, and upon it much misconception has been based. The Pacific coast, after leaving the canal, trends so much to the westward that vessels would not in any case depart far from it until between Acapulco and Mazatlan. Taking Mazatlan for example, we find the shortest distance line thence to Yokohama or Hongkong passes at no great distance from San Francisco and other California ports, which would present most favorable conditions of coaling and cargoes to the great lines of freight steamers that are to use the canal. I therefore say that the natural route from Liverpool and New York to China and Japan, via the Nicaragua Canal, will be directly along the Pacific coast. There would not be a great divergence in touching at any Pacific port of the United States. This line will naturally touch at or near the Aleutian group of islands, where a coaling station can be placed. The development of trade on the Pacific coast will be assisted by the Nicaragua Canal. Part of the trade between Yokohama and Shanghai will be assisted.

Another point to be considered is that steamers must make their trips short in order that they may carry only a small amount of coal, so as to not infringe unduly upon the space allotted to cargo. For this reason, vessels from London going by the Suez Canal all follow lines where they can stop frequently in order not to interfere with the cargo by taking

large quantities of coal aboard and for the local cargo business as well. I mention this to show that it is natural that this should be done upon routes which will use the Nicaragua Canal. Puget Sound and the Aleutian group will give other coaling stations and new cargoes to the north and west, and sailing from the Aleutian group to Hakodadi, Yokohama, and Shanghai we have a route as favorable as any that could be arranged, even if you could select the ports and place them at the points desired.

These facts are not understood, I believe, by nine-tenths of the business men, nor by ninety-nine out of every hundred people of less education, and one of the immediate results of this ignorance is seen in the newspaper statements to the effect that the American continent will be left out of the current of trade passing from Europe to Asia by way of the Nicaragua Canal. If I have made myself clear in this respect, I think I have done as much as I can now do without the figures necessary to discuss matters more in detail before your honorable committee.

Mr. DOOLITTLE. Can you give us the figures in reference to the tonnage of the canal?

Captain TAYLOR. I made most of the older estimates myself, but I have not them with me. I would be very glad to send them to your committee. I can say, within wide limits, without figuring on anything which would be brought into existence by the canal, but which would need the canal as soon as it was built, in order to bring the right result in somewhere between our figures. In 1888 we made figures for 1895, the time when we expected the canal to be completed, and we estimated a maximum of 8,000,000 tons without knowing what would be the exact tolls per ton, and so we figured upon those charged in the Suez Canal, which were in the neighborhood of $1.50 per ton. We based our figures on various sources—the traffic around Cape Horn; upon that between New Orleans, New York, and Callao, and other points in western South America; upon a certain amount of traffic between New York and San Francisco, Seattle, and San Diego, and upon an almost immediate trade between New Orleans and the points in that neighborhood. We included, I think, such trade as might go from New York to Yokohama, and from Liverpool to Seattle and Tacoma, and from San Francisco to Liverpool.

Mr. DOOLITTLE. You have not reckoned any wheat from the State of Washington at Puget Sound?

Captain TAYLOR. The figures included the wheat from San Francisco. I can not remember as to Seattle. The figures include some lumber shipped from Puget Sound.

Mr. BENNETT. What would be the probable cost per annum of maintenance of this canal?

Captain TAYLOR. It would be about $1,500,000 per year. That was about our figure.

Mr. BENNETT. You say that you estimate the maximum figure of the cost of the canal at $85,000,000?

Captain TAYLOR. The board made an estimate of $87,000,000. This estimate was absolutely unprejudiced, but we thought, and I believe the company still thinks, that the canal can be built for $65,000,000.

Mr. BENNETT. And you give the maximum cost of running the canal at $1,500,000?

Captain TAYLOR. We saw no reason to put it above $750,000; but we chose to do so, basing it on the Suez Canal, which has had a large expense because of the drifting sand, from which the Nicaragua Canal would be free.

Mr. DOOLITTLE. I want you to explain the effect of the doldrums at Panama?

Captain TAYLOR. The doldrums extend north and south of the equator. They vary, and, according as the sun goes north and south in declination, the belt moves north and south. The heart of that belt seems to be a little north of the equator and it includes Panama. Speaking only from memory, this belt of calms covers the Panama Canal line during about ten months of every year, during which time the light and variable winds make it difficult for sailing ships to move. The Nicaragua Canal may be said to be outside of that belt, and during ten months of the year they have breezes such as to enable sailing vessels to approach or leave the harbors on both sides of the isthmus. The northeast trade wind, blowing from about east by north at Greytown, is nearly an on-shore wind at Greytown, but sailing vessels would rarely have difficulty in clawing offshore, and then towboats would always be at hand.

Mr. WANGER. What distance would towage be required?

Captain TAYLOR. In this case the maximum would be 6 or 8 miles. I have been on both sides in sailing ships and steamers, and there was no time when I felt that I would be delayed more than a day or two. I was speaking only of the fresh breezes blowing on shore, which, not being gales of wind, are what sailing vessels like. Vessels only need an offing from the breakwater 3 or 4 miles.

Mr. BENNETT. As a matter of fact, can sailing vessels afford to pay $1.50 per ton for going through the canal?

Captain TAYLOR. Yes, sir; and make a large amount of money, rather than go around Cape Horn.

The CHAIRMAN. I think it has been stated that, with this canal, sailing vessels may be done away with.

Captain TAYLOR. They will not grow less, nor pass away, but their relative importance will grow less, because of the greater number of steamers. The tonnage of sailing vessels will not diminish, but where one will be seen in the canal per day there will be twenty or thirty steamers. There are many remarks that might be made as regards the use of the canal which one could occupy days in discussing, but I think what the committee wanted me to touch upon more than anything else was the points upon which some objection has been made to the canal and to which some reply could be made.

Various matters of great interest will follow the construction of the canal. One is the question of a great tropical metropolis which may be expected to arise in Central America upon or near the canal. This, of course, is in the realm of fancy; it is coming, but when we can not tell.

One of the gentlemen of the committee wished me to say something about the military and naval aspect of the question. I have the permission of the Secretary of the Navy to appear before you and state, so far as I can, what you wish to know about it. The question has been raised in the newspapers of late that if this canal be owned by the United States, or controlled by our Government, there will be a great deal of trouble to retain it; that foreign powers with superior fleets will attack it, and that we will be compelled to use a large force, and that in favoring this canal we will be building, or helping to build, something that will weaken us; and that the position of the canal will be a dangerous and isolated one. I do not think that that can be answered or intelligently discussed, because it is according to one's point of view. It is something like the objections which may be made

to the accumulation of wealth for fear it will be stolen, or like objections to the acquiring of a handsome house because it might be burned down, or because it would give more or less trouble to keep in order. I do not know how to answer that question in any other way. The canal will be a most valuable possession to that country that shall own or control it.

Mr. PATTERSON. The only trouble about your illustration is that I do not think any other power could take this canal.

Captain TAYLOR. I am quite sure of that. The position of the canal is of great strategic importance, and I think that of itself will some day enable the United States to use a smaller naval force and a smaller military force, owing to the strength of the position which it will then hold.

Mr. PATTERSON. Have you given an estimate of the cost of the canal? I have not been present during all of your remarks.

Captain TAYLOR. I have given an estimate of the company when I was general manager, and also other estimates. The company estimated that it would cost $65,000,000. We then asked a board of the most eminent engineers of the United States, who were totally unprejudiced and who possessed no interest in the company in the way of stock or anything else, and they spent several months in making an exhaustive examination. That board was composed of the State engineer of New York, and Mr. Wellington, editor of the Engineering News, whose standing is well known; and also railroad engineers well known in the country, as well as one or two other men of scientific attainments. We had a commission of five. The company was not represented. I was at the time a director and the general manager, and we were very particular in that respect. This board stated that our estimates were good, but by reason of wishing to secure their estimates against all possibility of being too low they raised our figures to $87,000,000.

Mr. SHERMAN. They made a horizontal addition of 15 or 20 per cent on the cost?

Captain TAYLOR. About 20 per cent, as I remember. From that time on we took the figures which they left in our hands; but I think it will not cost anything like that figure now, because excavation is coming down very materially in cost as time goes on; still, their estimate has been retained.

Mr. PATTERSON. You have gone over the ground?

Captain TAYLOR. I know very little of the interior. My business was, first, that of promoting the company, and later that of vice-president and general manager in New York. I know more of the estimates in reference to the traffic, although I am not an expert. We in the Navy are not trained constructing engineers. I was on leave by the Government for the purpose of assisting in the promotion of the canal in reference to the engineering. I think you will hear from Chief Engineer Menocal.

Mr. PATTERSON. He is the engineer?

Captain TAYLOR. He is a civil engineer in the Navy, and has been prominent in his profession.

Mr. PATTERSON. He is a civil engineer?

Captain TAYLOR. Yes, sir; of distinction.

Mr. PATTERSON. From your knowledge of Professor Menocal, you place reliance upon his skill?

Captain TAYLOR. Yes, sir; a reliance based upon a long acquaintance. Mr. Menocal is certainly very competent for that work. You will hear from him fully and exhaustively.

Mr. PATTERSON. What is the consensus of opinion in reference to the canal among naval officers.

Captain TAYLOR. I have never heard but two officers question the wisdom of this project out of six or eight hundred whom I know, and I must have heard three or four hundred speak of it. It is a matter of frequent discussion among us in every form. Every officer in the Navy knows that country, because we are a great deal in the Caribbean Sea. We are called there quite frequently by political disturbances on the west side. We are there more than we are here. I have never heard but two officers who condemned it. One questioned whether it would add to our military strength to have it, and another doubted whether it would not injure our transcontinental railroads. It is favored among naval officers more universally than anything I know of.

Mr. PATTERSON. If you were a business man, would you come to the conclusion that this canal would cheapen rates across the continent?

Captain TAYLOR. I have no doubt it would increase the amount of goods transported from the Pacific Slope. It would give the railroads that much more money.

Mr. PATTERSON. The effect would be to introduce an important factor of competition to cheapen rates, practically throughout the country, and, at the same time, by increasing the volume of business, would permit the railroads to live and thrive.

Captain TAYLOR. My impression is that the volume of business would be increased to such an extent that it would resemble that occasion when the rates of postage being reduced there resulted a great increase in the amount of money received. I should think it would be the same in this case.

The CHAIRMAN. The suggestion has been made that the population would be so increased that there would be a great deal of passenger business which would add to the revenues of the railroads.

Captain TAYLOR. Yes, sir.

Mr. BENNETT. In your computations in reference to the probable traffic which would be received by the canal, was any traffic now carried by the transcontinental railroads taken into consideration?

Captain TAYLOR. None, as far as I remember, only the present traffic water-borne. We proposed that the tolls should be such that vessels can make a profit going through the canal.

Mr. BENNETT. You believe the minimum tonnage would be 5,000,000 tons?

Captain TAYLOR. Yes, sir; but if you desire to quote me I would prefer that you wait, because I shall be able to show the figures in that connection when I can get at my papers.

Mr. PATTERSON. I suppose you are able to give an intelligent opinion in respect to the trade winds at the point where this canal would cross the isthmus?

Captain TAYLOR. Yes, sir.

Mr. PATTERSON. I am told that at Panama sailing vessels practically could not use a canal there for the reason that the air is calm on both sides, whereas, on the Nicaragua Canal, it has been insisted that sailing vessels would have the advantage of trade winds both in the Caribbean Sea and the Pacific Ocean.

Captain TAYLOR. That is true; I do not remember the exact figures. The belt stays over Panama about ten months of the year, and at Nicaragua it is calm perhaps only two months in the year. I have been eleven days in sight of the hills around Aspinwall, in command of the *Saratoga*, a sailing man-of-war, trying to get in.

I would suggest that if the chairman would send to the Navy Department for the charts of Lieutenant Maury they will show the calm belts. The situation is worse on the Pacific coast than on the Atlantic side. There is no difficulty in regard to winds at the Nicaragua Canal. You can be convinced of that when you examine these charts; but, pending that, I can state quite positively that the difficulties at Panama are very great, while they practically do not exist at Nicaragua.

Mr. PATTERSON. Some years ago a gentleman, whose name I will not mention, but who claimed to be familiar with these matters, was very much in favor of the Eads system.

Captain TAYLOR. The ship railway at Tehuantepec?

Mr. PATTERSON. Yes, sir; and he described the difficulties with the Nicaragua Canal to be these: That this canal was excavated for 26 miles through a ledge of rock, and that it was practically impossible for ships to go through without being injured, and without coming in contact with the sides of the canal, and all that sort of thing.

Captain TAYLOR. The entire distance of the Nicaragua Canal is 169 miles, of which there are 27 miles of canal, and the rest is river and lake. There are only about 2 miles of rock. The remainder is dredging in the open country. There is a rock cut of about 1¾ miles, and to that they add another piece, which makes about 2½ or 3 miles.

Mr. PATTERSON. In passing through in winds or storms, would a vessel be liable to be pushed up against the sides of the canal and be injured?

Captain TAYLOR. In a deep rock cut there are no side winds, and in the open country a vessel could run up aginst the soft sides and would not be hurt. On the Suez Canal they have sand storms, and sometimes vessels are forced against the sides in a storm, but they are not injured. I have laid there all night in a ship without injury or discomfort.

Mr. PATTERSON. I did not think there was anything in the complaint, but I wanted to get it in the record, as that was one of the points made against the canal.

Captain TAYLOR. It is without foundation in fact. The amount of rock cut is so small that the statement may be regarded as a mistake. There is a deep rock cut in this plan, but it was not forced upon our engineers as a necessity; it was taken as a favorable alternative. The canal might pass around it by taking another route, if it was desired, but it would be 7 miles longer. The rock cut is an advantage, because a portion of the material excavated is needed for the jetties at Greytown for the Ochoa dam, for revetments of the banks at certain places which are liable to wash. We have to get much rock from somewhere, and this was thought to be a favorable location to obtain it. It is in some respects the same principle which governs a railroad engineer in making his "cuts" and "fills."

Mr. CORLISS. Mr. Miller said that practically the bottom of the canal was free sand and clay. Did your commission have anything to say on that subject?

Captain TAYLOR. We had borings made to a certain extent, and the commission appointed by the company gave their opinion and made some suggestions. There is no reason to decide all minor details of the canal now. These matters are not usually decided in a great work like this until the time for each detail comes. Sufficient contour lines and borings and gaugings are completed to make it certain that the project is feasible and economical. At a later period, as we approach each detail of the work, one hundred borings and gaugings and contours will be undertaken for every one made before. It is nothing against the

project that there should be a preliminary examination for preliminary work, and full examination for the detailed work. All great works proceed in this way.

Mr. BENNETT. If you have finished, I suppose you will prepare and forward us the papers which you have promised?

Captain TAYLOR. I have finished, and I will recommend you now to Mr. Menocal, who will appear before you as soon as he recovers.

Adjourned.

COMMITTEE ON INTERSTATE AND FOREIGN COMMERCE,
Thursday, April 2, 1896.

The Committee on Interstate and Foreign Commerce this day met, Hon. William P. Hepburn in the chair.

The committee had under consideration the subject of the Nicaragua Canal.

STATEMENT OF MR. LINDON W. BATES, OF CHICAGO.

Mr. Bates said:

Mr. CHAIRMAN AND GENTLEMEN: In being here I accept the invitation, as I understand it, to speak from the standpoint both of a large holder of property on the Pacific Coast and to represent American invention and contractors in such relations as to what they have done and what they can do as far as the Nicaragua Canal is concerned, and I would say that I have been familiar with the reports of the Nicaragua Canal for the last seven or eight years, and have conferred very frequently with officers of the company, and more particularly with the subordinates who did the actual work of boring and surveying on the line of the canal. I have up to within a year ago been engaged upon the Chicago Drainage Canal, which affords the most modern parallel to the work of the Nicaragua Canal, treating it from an American standpoint.

Mr. DOOLITTLE. I wish you would state whether you are a civil engineer, how long you have been in the practice of your profession, and also what experience you have had in contracting; that is, covering what period?

Mr. BATES. I am a civil engineer, coming from the Yale Scientific School; have been engaged upon the Chicago, Burlington and Quincy, and afterwards upon nearly all the transcontinental lines during their construction since 1878, acting both as an engineer and subsequently as a contractor for a considerable portion of the actual work of construction in California, Oregon, and Washington. Latterly I have been engaged for the Mississippi River Commission in the construction of a very large dredging plant which has just been finished, which upon the final official test has demonstrated its capacity of 6,000 cubic yards per hour on ordinary river sand excavated from the bar and thrown a distance of 1,000 feet through a pipe line. Its record is something like ten times the record achieved in the world before, and is, perhaps, unique in Government annals, in that I have given in the results achieved four times beyond that which I guaranteed to do.

The work that this machine does is of special significance in reference to the Nicaragua Canal, because it embodies in itself power that is greater than that of all the machines and men and appliances which were gathered by Lesseps at Panama, and it is equivalent in its work

to more than an army of 60,000 men could do if they were given a shovel and wheelbarrow to take the sand a distance of a quarter of a mile as she is sending it. In addition to that, upon the Chicago Drainage Canal I have had much more than the ordinary facilities afforded by the chief engineer and trustees of the sanitary district, as well as by the successful contractors, who are my personal friends, and all of them are intensely interested in this Nicaragua project to know what are the most modern appliances for the actual execution of such work as the Nicaragua Canal, and I will say that those men are the men above all others who are qualified to say what it will cost to build the Nicaragua Canal. They are the men who do the thing, not those who make the preliminary plans. There has been upon the Chicago Drainage Canal a survival of the fittest, and there are now five or six men or firms who have been eminently successful in designing the best apparatus for executing their work and in making a profit at the lowest canal prices which have ever obtained in any country, and I would suggest, if it be desired by the committee, that I will give them the names, which I will recite, of men whom I consider, from the experience I have had, as experts qualified to give the very best information upon the actual work of construction that is contemplated in the canal.

The CHAIRMAN. Will you give some of those names just there?

Mr. BATES. I would give the name of Mr. Brown, of the Brown Hoist Company, of Cleveland, Ohio, and the Lidgerwood Manufacturing Company, of New York, as being especially skilled in the transportation of spoil from the excavation into a given spoil bank; I would give the name of the Repauno Chemical Company, whose office is in Chicago, as the best experts upon powder in this country, because they have furnished all the powder amounting to many tons of dynamite daily upon the canal. I would give the name of E. D. Smith & Co., of Philadelphia and Chicago. and of Mason, Hoge & Co., of Romeo; also the name of MacArthur Bros. & Co., of Chicago, and Christie & Lowe, of Chicago, as men who have been preeminently successful of all men who have taken a great interest in this canal, and who, I believe, would respond to an invitation to appear before the committee. I would also include the name of Lyman E. Cooley, of Chicago.

Speaking from the dredging standpoint, I would say that there are 40,000,000 yards of dredging upon the Nicaragua Canal and in the harbor of Greytown, and in the sand formation so far as it goes up toward the first lock, and in the harbor of Brito, and machines of the type which I have photographs of here and have myself operated and designed are capable of executing the work at a very great profit at the prices mentioned in the report of Mr. Menocal, and that with these machines the construction company could do the work for but a small percentage of these actual estimates. The work upon the Drainage Canal at Chicago has shown that for the different kinds of work different apparatus is necessary, and I would draw a special parallel between the Drainage Canal and the work upon the Nicaragua Canal lying between Lake Nicaragua and Brito. The average cut is about the same, except the prism of the Chicago canal is greater than that contemplated at the other point; but the actual type of machines which operate at Chicago and have been so successful would be particularly applicable to the division between the lake and the Pacific Ocean.

Mr. DOOLITTLE. How about the rock cut?

Mr. BATES. Speaking about the rock cut and organization, I would say, as contractors, there would be two ways of approaching the problem, either taking the surveys and borings and everything the Nicaragua

Canal Company have got and actually seeing the ground and forming a syndicate which would make a price, or the canal could really be built cheaper probably if the harbor at Greytown and railroad up to the Ochoa dam and the railroad to the coast were first constructed. Our experience upon the canal has demonstrated that the two lines of railroad, the Chicago Northern and the Santa Fe, running on either side of the canal, have been of inestimable service, and if the contractors had those conditions given and the line was divided into sections there are a large number of firms in this country of experience who would be glad to put in their figures upon a fair basis, and I will say that the problem of the divide cut and the excavation of material, requiring powder, drills, and transportation, could hardly be committed to hands which would solve the problem better of cheapness than to the very men who have handled the rockwork on the Chicago Drainage Canal, which in the aggregate is really greater than upon the Nicaragua.

Mr. DOOLITTLE. How about the appliances that have been made use of at Chicago for handling material in the rock cuts?

Mr. BATES. I have here a number of photographs [exhibiting same]; for instance, there is one which shows what is known as the Brown cantilever hoist. This is a novel apparatus, built especially for the canal, that has built what they call in Chicago the cantilever mountains. This machine actually cost probably not to exceed $14,000 or $15,000, and the Brown Hoist Company have been able to make contracts to furnish these machines themselves, and received as compensation for the removal of material from the excavation after it had been loaded on the skips 15 cents per cubic yard. It is my belief, from personal investigation, the actual cost to the company is not to exceed 5 cents per cubic yard for taking the material from the bottom of a 40-foot excavation and carrying it 300 feet and putting it in the spoil bank. I have here another form of transporting apparatus, which is known as the Lidgerwood Overhead Cable Way. That costs a little less than the Brown hoist, and has about the same cost of operation, perhaps a little more, but it would be especially advantageous in many situations upon the Nicaragua Canal.

Mr. DOOLITTLE. For what purpose is this last appliance?

Mr. BATES. That is for taking out rock from the excavation and putting it in the spoil bank.

Mr. DOOLITTLE. How far can it be carried in that way by the Lidgerwood machine?

Mr. BATES. I think there will be no trouble about the distance o. transportation. This, you understand, is a wire-rope tramway that will transport a great distance, but in this special form it would probably not be advantageous to carry it more than 1,000 feet.

Mr. DOOLITTLE. What would you say about the use of that machine in the rock cut and at Ochoa dam for removal of the material and the handling of it there?

Mr. BATES. Without going very definitely into it, I might say material from the divide cut could be carried on this railroad to the vicinity of Ochoa dam, and it might be advantageous from one standpoint of the contractor to use the overhead cable way in putting the material into the dam. But this has to be said, that every contractor who might have a proposition to take it would be very likely to solve it in his own different way, and the most peculiar thing, almost, in the canal has been that every man who had a section there has evolved a different method of handling and excavating his material, and each one of them has been novel and each has been successful. There is a form of derrick

[exhibiting photograph] used on the canal which is a pivoted derrick, with long arms swinging around and around. There is another one, showing the way the cantilever reaches over into the excavation.

Mr. NOONAN. When you take the material excavated to the place where you desire to make a dam, what process do you have of putting that in position to make it hold the water?

Mr. BATES. As I understand, the process at the Ochoa dam is that they propose to put in a loose-rock dam, which would be literally putting in so much rock that, with the collecting of the sediment, or, perhaps, the putting in of a core, it would prevent the filtration of water through it.

Mr. NOONAN. As an expert, do you approve of that mode?

Mr. BATES. I think that is the very best way to solve that problem. I have seen in California, for instance, what we call a sweet-water dam—masonry dam, with the arch toward the pressure—but that would not be feasible at Ochoa, and they have got there rock so available that I think there is not any question but what they can make a perfect success of it.

Mr. DOOLITTLE. It is only a question of sufficient material being deposited there, I suppose?

Mr. BATES. Yes.

Mr. NOONAN. I have heard it claimed by some that this mode of depositing stone and earth is a most perfect plan at the present day.

Mr. BATES. Well, for that particular purpose I think it would be. Now, there is another form [exhibiting photograph]. Here is one with a blast going on, and here is a photograph of one of the hydraulic dredges which are engaged on the canal, similar to the form I have mentioned on the Mississippi, except it is smaller. Here is a larger photograph showing this new dredge that has been built for the Mississippi River Commission, and here again is a detailed plan of the same. I will say the Drainage Canal contains five-sevenths of the total excavation to be made at Nicaragua.

The CHAIRMAN. What will be the total cost of this excavation on this Chicago Drainage Canal?

Mr. BATES. I think the last figures reached something like a total cost of the canal, including right of way, about $28,000,000. My impression is the right of way and other expenses have amounted to $3,000,000 or $4,000,000 of that sum.

Mr. DOOLITTLE. What is the depth of it at the bottom and at the top?

Mr. BATES. On the earth sections of the canal, which extend about 12 miles out from the beginning, the bottom width is to be 210 feet, and that width also extending through the glacial drift section, which goes on about 10 miles farther. In the rock section the slope of the canal is increased a little, and that admits of narrowing the prism of the canal. It is 160 feet wide on the bottom, with nearly vertical slopes. Those slopes may be vertical there, because the rock is limestone rock, and in the rock section the first process is clearing the ground of obstructions and starting the channeling machines. Those channeling machines cut a groove representing either side of the canal 11 feet deep, and then the drills, run by compressed air or by steam, are put to work upon the face, and the material is broken up so it can be loaded on the skips of the cantalevers, or the overhead cable way, or any other method which is adopted for transporting the material.

Mr. DOOLITTLE. What is the length of the Drainage Canal?

Mr. BATES. The total length is about 30 miles.

The CHAIRMAN. And the depth?

Mr. BATES. The depth of water will be 26 feet and the average cut may be said to be about 40 to 42 feet deep, which is about the same as the cut from the lake to the Pacific Ocean in Nicaragua, or just about the same. These photographs also show the masonry walls which have been put up along some sections where the glacial drifts or alluvial deposits overlie the solid rock.

Mr. DOOLITTLE. Have you ever handled igneous rock?

Mr. BATES. Yes.

Mr. DOOLITTLE. And know of the difficulties attending that sort of work, and the difficulties attending the handling of limestone rock on this Drainage Canal?

Mr. BATES. Yes. I can best compare that with the work on the Columbia River, where I was engaged in 1881 on work for the Oregon Navigation Company, and when we first began nobody offered to do it for less than $3 a yard, but after the construction began we found we were able to handle the rock under railway conditions, the igneous rock, or basalt, as we called it out there, at $1.20 per cubic yard. I would like to have all the rock I could excavate on railway work at that price.

Mr. DOOLITTLE. What has been the cost of handling the limestone rock on the Drainage Canal?

Mr. BATES. The actual cost of handling the limestone rock has not been to exceed 50 cents per cubic yard, and that includes the whole work. Of course, there have been some contractors who spent more money on it, because they did not rise to the occasion as the successful men did.

Mr. DOOLITTLE. Would you say, from the descriptions you have in these reports of the rock in the rock cut at Nicaragua, that the same appliances could be made use of and the same labor, and that the cost would be greatly increased necessarily, or otherwise?

Mr. BATES. I would express the opinion that Mr. Menocal's estimates are adequate for the handling of any material on the canal, with a fair profit to the contractor.

The CHAIRMAN. Would you be willing to take a contract for the whole canal at the estimates of Mr. Menocal?

Mr. BATES. Yes; and I should do so with the belief that I would make a very considerable profit out of it.

Mr. DOOLITTLE. Do you believe that a force could be organized here within the country to complete the work according to those plans and specifications, after having gone over them thoroughly as you have, within this estimate—I mean to take the work up right now and carry it on?

Mr. BATES. I am thoroughly satisfied it could be done. I would like to add from the standpoint of a practical property owner on the Pacific Coast that, knowing the condition of my property and that of my friends out there and being thoroughly familiar with the agricultural and timber resources of the country and the conditions that the people are in out there, I think that there is not a man from San Diego to Puget Sound but who feels that the Nicaragua Canal will be his salvation, and from a railroad standpoint I think that everyone who is familiar with what we call the California boom, and we recollect that we were able to go from the Mississippi Valley to San Francisco at from $5 to $10 railroad fare, and that the railroads in California were never more prosperous than they were from the large local business which developed from the population of 200,000 people who went in under that excitement, and with the assured construction of the Nicaragua Canal there would be inaugurated a new era for the Pacific Coast which

would very largely increase the earnings, especially the local earnings, of every railroad company on the coast, and while there might be gross freights taken in large amounts through the canal there would be a much vaster tonnage and very much larger amount of passenger earnings, resulting from the increase of prosperity and population on the Pacific Coast, to the railroads than they can ever hope to secure under present conditions.

Mr. DOOLITTLE. I would like to ask you if the Nicaragua Canal has been a subject of conversation between yourself and other successful men on the Chicago Drainage Canal, and about the judgment of those men as expressed in those talks you have had with them concerning the practicability of that and the feasibility of it.

Mr. BATES. I will say I have often talked with the gentlemen whom I have named here as contractors on the line, and that they are all of them familiar with the literature and reports that have been published, and they would like to be able to be part of the construction of the Nicaragua Canal, just as they have been part of the success of the Chicago Drainage Canal. They are men who have got invested in plants upon the canal now upward of $3,000,000, and they have been under bonds to the sanitary canal to a similar amount.

Mr. DOOLITTLE. I wish you would here state whether a portion of that plant could be made use of profitably at Nicaragua.

Mr. BATES. I think there are some portions of the plant on the Drainage Canal which could be used to advantage at Nicaragua, but, on the other hand, there are little parts of it which have been worn out in the service and which it would not pay to transport to a new point; but, further, the most valuable thing in reference to it has been that they have evolved methods of knowing how to do the thing the cheapest.

Mr. Chairman, I will leave these photographs and maps here, so that other members of the committee will have an opportunity to look at them if they so desire.

Thereupon the committee adjourned.

COMMITTEE ON INTERSTATE AND FOREIGN COMMERCE,
Washington, D. C., Saturday, April 11, 1896.

The committee met at 10.30 a. m. for the purpose of continuing hearings on the question of the Nicaragua Canal.

STATEMENT OF MR. A. G. MENOCAL, OF THE NAVY DEPARTMENT.

Mr. CHAIRMAN AND GENTLEMEN OF THE COMMITTEE: I have prepared a statement in which I propose to answer some of the criticisms which have been made against the Nicaragua Canal. I am unable to read it, as I am suffering from bronchitis, and I shall have to ask that the paper be read by some member of the committee, or by a gentleman present who is familiar with the geographical names in Nicaragua. If you will allow this gentleman to read it, I will answer any questions which any member of the committee may desire to ask as the reading is proceeded with.

Mr. DOOLITTLE. This is a paper which has been prepared comprehensively, and it can be read, if the members desire to have it; but perhaps we would prefer to have the statement printed, and hear Mr. Menocal in regard to the work.

Mr. PATTERSON. I would rather that the paper were left to be inserted in the notes, and printed, and that Mr. Menocal take a seat at the table and let us have a table talk, as it were. The chairman can draw out the information which we desire by questions.

The CHAIRMAN. How long have you been connected with this enterprise?

Mr. MENOCAL. Since 1872.

The CHAIRMAN. What portion of that time have you spent in Nicaragua in the vicinity of the line of the canal?

Mr. MENOCAL. In the aggregate, more than six years. I have been in Nicaragua fifteen or sixteen times, and have remained there six months to a year at a time. I have spent on the line of the canal and its surroundings about six years.

The CHAIRMAN. During the time of your residence there, what has been your observation as to the precipitation and volume of water discharged from the lake?

Mr. MENOCAL. I have made observations as to the rainfall and discharge of the streams and other meteorological conditions.

The CHAIRMAN. Your observations have enabled you to understand every class of phenomena affecting the canal?

Mr. MENOCAL. Entirely. I do not know that I have a knowledge of what is termed the regimen of the rivers, but I have the maximum and minimum of the rainfall and the floods for a number of years. By observation I have arrived at conclusions in regard to that, especially in Nicaragua, where the rainfall varies. The rainfall changes over 100 inches from one year to another, and in some places it changes as much as 200 inches in a distance of country not more than 200 miles in area.

In order to arrive at the extent or estimate of rainfall, observations must be carried on for a long number of years, and even then the observations for a series of years may be entirely upset by the observations of another series of years.

The CHAIRMAN. Have those observations been preserved?

Mr. MENOCAL. Yes, sir; they have during the time that I was there. They have not been preserved for an uninterrupted series of years, as they should have been, because we have not remained in the country permanently; but during the time I was there I made observations regularly.

The CHAIRMAN. Were they sufficient?

Mr. MENOCAL. Yes, sir; to arrive at an approximate of the floods of all the rivers and of the lake. What I have done has been to estimate the maximum from observations and then to duplicate them, and I base the work proposed for the canal on those figures.

The CHAIRMAN. The minimum rainfall seems to be twice as great as the maximum?

Mr. MENOCAL. Yes, sir; in Grey Town the precipitation is as much as 296 inches. That was according to daily observations made during three years.

Mr. JOY. Do you mean a rainfall of 296 inches in one year?

Mr. MENOCAL. Yes, sir. It varies very much. There is no condition of dry or wet season on the Atlantic coast. It rains most all the year through, and every day, and for that reason the rainfall is usually great. West of the lake the conditions are different. The rainfall is less, and the period of dry and wet season runs each about six months in the year, with an occasional rain every two or three days in the rainy season. As you approach the Atlantic coast the rainfall increases gradually, and from 16 to 20 miles from Greytown on the coast the

rainfall increases very much. In Greytown we have observed rainfall of as much as 296 inches in one year. The largest flood which has been observed in the San Juan River was 42,000 cubic feet per second. In estimating weirs and sluices I have increased that volume 50 per cent, estimating the maximum flood at 63,000 cubic feet per second. I double that in providing for weirs and sluice discharge, and provide for 125,000 cubic feet per second.

The board of engineers base their estimate of the maximum at 150,000 cubic feet per second. I regard that as grossly exaggerated, but it is only a question of weirs. If 125,000 feet, for which I have estimated, is not sufficient, let us provide for 150,000 cubic feet. It is only a comparatively small increase of cost.

The CHAIRMAN. How long have you been engaged in your profession as an enginer?

Mr. MENOCAL. Since 1862.

The CHAIRMAN. Have you been in the Navy during that time?

Mr. MENOCAL. I have been in the Navy since 1872. I graduated from the Polytechnic School in Troy, N. Y., in 1862, and have been engaged in my profession ever since.

The CHAIRMAN. How long have you been connected with the work on this canal?

Mr. MENOCAL. Since March, 1872; over twenty-four years.

The CHAIRMAN. What relation have you to it now?

Mr. MENOCAL. I do not know that I have any close relation, any more than I have been chief engineer of the company. I made the surveys through Nicaragua and Panama as chief engineer, the Government having sent me.

The CHAIRMAN. Are you a stockholder in the canal?

Mr. MENOCAL. I have a small interest. I hold some stock. It is only a little which I procured when the company was short of funds, and I contributed some money to help it along.

The CHAIRMAN. Has the work done by the Canal Company in the furtherance of its enterprise been done under your supervision?

Mr. MENOCAL. Yes, sir.

The CHAIRMAN. Has this work been done upon your estimates, and within the estimates made by you?

Mr. MENOCAL. It has been done inside my estimates. I estimated the railroad at $60,000 per mile, and the road was built by contract for $32,000 per mile. I estimated the telegraph line at $400 per mile, and it was built for less. The clearing of the line was done for less than the estimate, and the same is true of other work.

The CHAIRMAN. Have you knowledge of what amount of money has been actually expended?

Mr. MENOCAL. I know what the work cost, and I know the condition of it now. I was in Nicaragua with the board of engineers.

The CHAIRMAN. What work has been done?

Mr. MENOCAL. We have built 1,000 feet of breakwater; we have dredged a mile of the canal, and cleared the land of trees and rubbish and completed surveys; we have made borings, put up a number of buildings and wharves; we have dredged some in the harbor of Greyton, and built 125 miles of telegraph line; we have put up machine shops, carpenter shops, and things like that.

The CHAIRMAN. Has any work been done in the canal proper?

Mr. MENOCAL. We have built about a mile of the canal to the depth of 17 feet.

The CHAIRMAN. When was this work done?

Mr. MENOCAL. In 1889 to 1891.

The CHAIRMAN. What is the condition of that work now?

Mr. MENOCAL. I want to say that we have also built 12 miles of railroad from Greytown toward the interior. In regard to the condition of the work, it is this: The canal has been excavated through swamps a mile from Greytown, and is in the same condition in which it was left when the work stopped in 1891. The banks are vertical; the material deposited remains the same as when the work was suspended; there have been no slides in the excavation or their banks; the railroad is in excellent condition with the exception that the ties are badly rotted. The ties were pine imported from the United States. The timber of Nicaragua is unfit for railroad ties. Those ties were exported from the United States, and were creosoted, but the creosoting was very imperfectly done, so that they have rotted out. Otherwise, the railroad is in good condition. The banks are about the same as when the work was suspended. The embankments are perfect, and the rails show very little oxidation. The bridges are in excellent condition, and, to my great surprise, we found that we had no trouble in going over the line, being pulled by men in hand cart.

The CHAIRMAN. When you were there this last summer, did you use the road by trains?

Mr. MENOCAL. Not by locomotives. We went over the road in hand cars, propelled by men, making about 8 miles an hour. The reason why the locomotive was not used was on account of the condition of the ties.

The CHAIRMAN. What is the condition of the breakwater?

Mr. MENOCAL. It is bad. It was a temporary structure built of creosoted piles, and it was to be made of stone into deep water. It was intended to fill it with stone as soon as the railroad was built to the rock excavation; but the work was suspended before the railroad was carried to the rock excavation, and this breakwater was attacked by the teredo, so that it is in a very bad condition. During the time the breakwater was in good condition, the channel on the lee side was maintained to the depth of 14 feet, so that the ocean steamers came into the harbor.

The CHAIRMAN. When the breakwater is built, do you expect that the flowage of water from the river will scour the channel?

Mr. MENOCAL. No, sir. The plan is not based upon that principle. The harbor is not closed through sediment brought down by the river directly to the harbor, but by the shifting of the sands—by the action of the waves striking the beach at an angle of about 45 degrees. The sand will accumulate to the eastward of the breakwater. We will then be able to dredge the channel, and as the supply of sand is stopped there will be nothing to fill the channel afterwards.

The CHAIRMAN. Can you give to the committee an approximate estimate of the actual expenditure of money required in this enterprise—that is, can you give us the fiscal estimates to carry it forward?

Mr. MENOCAL. Your question is, how much will be required to be spent to build it. I have nothing to do with the financial affairs of the company. I know that the company has spent between $3,000,000 and $4,000,000.

The CHAIRMAN. Do you mean that between $3,000,000 and $4,000,000 have been actually expended on the work?

Mr. MENOCAL. I am speaking of the work. I do not know what expenditure the company has made upon other things. In Nicaragua the work they have done has amounted to between $3,000,000 and $4,000,000.

The CHAIRMAN. Does that include the dredges and other machinery?

Mr. MENOCAL. It includes the plant, the dredges, the locomotives, and the material on hand when the work was suspended.

The CHAIRMAN. What would be your estimate of the present actual value of the work which has been done in actual construction?

Mr. MENOCAL. I would prefer not to give that, because I have made no careful estimate lately, and whatever I would say might be far from the mark.

The CHAIRMAN. Is there any considerable portion of the work that could be made available, or which it would be economical to use?

Mr. MENOCAL. A part of it could be used. The dredges are not in that condition to be put at work at present, but two of the four dredges could be used. The locomotives are in good condition. They have been well housed, and certainly three of them are in good condition. The buildings are in extraordinary good condition, considering the way they have been neglected. The foundations are good, and the woodwork is sound. All the railroad is good, with the exception of the ties. The embankments are well preserved, and the rails are in fair condition. The telegraph line is badly maintained. It would have to be cleared and poles would have to be erected. The ground work of the telegraph is good.

The CHAIRMAN. In view of the improvements which have been made in dredging machines, would it be economical for the company to use the old machines?

Mr. MENOCAL. I think it would not be—not for the work which has been estimated. I think it would be more economical to use more improved machines. Some of the dredges there could be of service for certain purposes.

The CHAIRMAN. What is the capacity of those dredges?

Mr. MENOCAL. Ten thousand cubic yards each per day of twenty hours.

Mr. DOOLITTLE. You work twenty-four hours?

Mr. MENOCAL. Yes; but there is some time lost in cleaning boilers and making slight repairs. We have never had more than two of the dredges at work. The company did not have the whole plant at work at any one time. We did not have a sufficient number of scows, and we did not have enough money and material to employ the necessary force. The company was in expectation of more funds, but by reason of financial difficulties they were prevented from doing the work properly and economically.

The CHAIRMAN. What is your estimate of the dredging to be done in the harbor at Greytown and on the other side?

Mr. MENOCAL. I think all the dredging, speaking approximately from memory, would amount to about 25,000,000 cubic yards.

The CHAIRMAN. Are you familiar with the modern Bates dredge?

Mr. MENOCAL. Yes, sir. I have not seen that dredge at work, but I have seen descriptions of the dredge.

The CHAIRMAN. In what portion of the canal could that dredge be used?

Mr. MENOCAL. All the material could be removed with that dredge.

Mr. BENNETT. At what cost per cubic yard?

Mr. MENOCAL. It would not cost more than 6 or 8 cents per cubic yard. They are doing very extensive dredging at the harbor in Mobile, and have removed vast quantities of material and dumped it 6 miles out at sea for 7 cents per cubic yard, and the contractor seems to be doing well.

The CHAIRMAN. When you make an estimate of 25,000,000 cubic yards, does that include all the dredging for the canal?

Mr. MENOCAL. It is all the dredging of the canal, the lake, the river, and harbor.

The CHAIRMAN. If you were to become the contractor for that whole work, how much would you diminish your bid by reason of the work already done?

Mr. MENOCAL. I would diminish it by a considerable amount—50 per cent, I should say.

The CHAIRMAN. Would it be worth so much as that?

Mr. MENOCAL. I think it would, if properly utilized.

The CHAIRMAN. Were you the agent of the company at the time the concessions were given?

Mr. MENOCAL. Yes, sir; there was no company then.

The CHAIRMAN. State what was done.

Mr. MENOCAL. I had made surveys in Nicaragua, became convinced of the practicability of the scheme, and the gentlemen interested in the matter were also believers in the construction of the canal, and they organized a preliminary company, if a company can be so called. It was nothing but an association. A few of the gentlemen met and asked if I would like to go to Nicaragua and get concessions for the building of a canal. I volunteered to do it. I had been in the country and knew the officials. I went to Nicaragua and got these concessions, and the gentlemen who were interested in the scheme contributed the money for this purpose. When I got to Nicaragua I had no great difficulty in obtaining the concession, and when I came back I turned it over to them. That was my connection with it.

One of the conditions was that final surveys should be completed within eighteen months from the date of the concession. I was asked by the association of gentlemen to go to Nicaragua and make final locations, and I did so, and plans were submitted in time. Afterwards I was asked to go to Costa Rica and get similar concessions to those granted by Nicaragua, and I did so, and turned them over to these gentlemen. I did all this without compensation, except the interest I had in seeing the canal built, believing in it as an engineering proposition.

The CHAIRMAN. Those concessions were made in the form of contracts, were they?

Mr. MENOCAL. They were in the form of contracts between the Government of Nicaragua and this association of gentlemen, with the power on the part of the association to transfer the concessions to a company or organization. When the company was subsequently organized the concessions were transferred to the company.

The CHAIRMAN. What provision is there, if any, in that construction grant prohibiting transfer to a Government?

Mr. MENOCAL. There is such a provision—that it was not to be transferred to any Government as a whole.

Mr. BENNETT. By whom was that inserted?

Mr. MENOCAL. By the Government of Nicaragua. That clause was in all the concessions which the Government had made to other parties, and it was inserted in this one.

The CHAIRMAN. Would there be any violation of the terms of the concession if this association of gentlemen should make an arrangement whereby the Government would obtain control through owning the majority of the stock?

Mr. MENOCAL. I do not think so. I do not see how there can be, because the company would have the right to sell its stock in the

market to such parties as wanted to buy, whether they were agents of the Government or private individuals. The concession does not prohibit the company from selling its stock to the best bidder.

The CHAIRMAN. That would be one method by which the company could transfer it, perhaps?

Mr. MENOCAL. The concession need not be transferred. The company will be in existence, and the majority of the shareholders will control that company, and if the Government holds a majority of the stock, it owns the concession without its being transferred. That is my idea. I see no violation of the concession, and I may say that the officials in Nicaragua have taken the same view.

The CHAIRMAN. Have you any objection to stating what consideration in money was given for that concession?

Mr. MENOCAL. The Government of Nicaragua was paid $100,000. Fifty thousand dollars was paid to the Government for the right of way west of the lake.

The CHAIRMAN. Was any money consideration paid to Costa Rica?

Mr. MENOCAL. No, sir. There passed through my hands $100,000 of American gold which was paid to the Government of Nicaragua. If anything else has been paid, I am not aware of it. This money was paid at the time the concessions were made.

The CHAIRMAN. What other obligations were assumed with reference to giving stock?

Mr. MENOCAL. The Government of Nicaragua was to receive 6 per cent, and the Government of Costa Rica one-half of that, or 3 per cent.

The CHAIRMAN. Have you any knowledge of the liabilities of the present company?

Mr. MENOCAL. No, sir; none whatever. My connection with the company is entirely professional. When they have wanted my services as an engineer I have always been willing, and have been able, so far, to assist them. I have nothing to do with the negotiations of the company, and could not tell you now how the stock stands. In fact I have no time for that.

The CHAIRMAN. You have no knowledge as to the stockholders or as to the finances?

Mr. MENOCAL. No, sir. I am not a stockholder as a speculator. I am not acting as an investor. My wife had a little money, and when the company was in financial straits we put it in.

Mr. PATTERSON. During all this period you were an officer of the United States?

Mr. MENOCAL. I was; and I was given permission by the Secretary of the Navy, Mr. Whitney, to accept the position of chief engineer of the company—if you refer to the time of the construction and to the concessions.

Mr. PATTERSON. During this whole service.

Mr. MENOCAL. All my service has been given to the company under orders from the Government.

Mr. PATTERSON. During that time you were in the service of the Government?

Mr. MENOCAL. Yes, sir. I have made surveys as the chief engineer and as the head of a surveying expedition as an officer of the Government. I was ordered there to do this work.

Mr. PATTERSON. How long have you been an officer of the Government?

Mr. MENOCAL. Since 1872 in the Navy. Whenever I have gone to Nicaragua to do anything I have done so with the special permission

of the Government to engage myself in that work, knowing exactly for what purpose I was sent, and I have with me an indorsement on my application from Secretary Whitney stating the great importance to the people of the United States of this enterprise, and that it was the least the Government could do to give me this leave in order that my services could be given to the enterprise.

Mr. BENNETT. Usually in engineering work of this character it is done in sections, and the cost of each section is estimated?

Mr. MENOCAL. Yes, sir.

Mr. BENNETT. Which section of the canal is most expensive?

Mr. MENOCAL. The most expensive section is the deep excavation 2⅞ miles, nearly 3 miles—a little over 15,000 feet. That represents 21 per cent of the cost of the whole.

Mr. BENNETT. From the harbor at Greytown, is that one section?

Mr. MENOCAL. That is one section, as far as the deep cut; then to the river is another section; then from the river to the lake is another section. The fourth section is between the lake and the Pacific Ocean.

Mr. BENNETT. The section from Greytown is the most expensive?

Mr. MENOCAL. Yes.

Mr. BENNETT. At what do you estimate the cost of the Ochoa dam?

Mr. MENOCAL. Inside of $2,000,000.

Mr. BENNETT. What do you estimate the cost of the middle section?

Mr. MENOCAL. The deep cut? It is difficult to remember those figures, but about $13,000,000, I should think, speaking from memory.

Mr. BENNETT. At what do you estimate the cost of the section between Greytown and the deep cut?

Mr. MENOCAL. The canal, locks and all, would cost about $10,000,000.

Mr. BENNETT. Then you go over to the other side of the lake, where there are two dams and wasteweir and the Ochoa dam?

Mr. MENOCAL. There is only one weir. Weirs are not expensive. They can be built on the top of the hill on the solid foundation, and would require only strengthening.

Mr. BENNETT. From the deep cut to the other side are there no especial engineering difficulties to overcome?

Mr. MENOCAL. There is no serious engineering work in the whole line of the canal, any more than we meet with every day. The Ochoa dam is a heavy piece of work. It is not regarded as a serious undertaking, considering modern methods.

Mr. BENNETT. From the deep cut to the other side of the lake there is no practical difficulty, nothing to be done but dredging?

Mr. MENOCAL. Dredging the lake and river. Between the lake and the Pacific the excavations are small—70 feet to the bottom of the canal and 42 feet to the level of the canal.

Mr. BENNETT. What would be your estimate of construction from the lake to the Pacific coast?

Mr. MENOCAL. The whole section is estimated at $14,000,000.

Mr. SHERMAN. Is it not true that the cost of every portion of the work of this canal has, by reason of the invention of modern machinery, been decreased since you made your estimate?

Mr. MENOCAL. Very much so. Our estimates were nearly double what similar work has been done for in this country since that time.

Mr. BENNETT. You have only gotten up to $40,000,000 for the work in the figures you have given me.

Mr. MENOCAL. There is other detailed work of importance, such as the harbor and breakwater. The full estimate is $65,000,000.

Mr. BENNETT. Do you think it can be completed for $65,000,000?

Mr. MENOCAL. It can be completed inside of $70,000,000, and built of the dimensions proposed—a ship canal larger than any in the world to-day.

Mr. BENNETT. To what depth of water?

Mr. MENOCAL. Thirty feet throughout, except at the level of the sea, where I have estimated only 28 feet, which gives a proper depth of water. The reason the estimate was limited to that was because that is all the traffic requires, and it can be increased to a greater depth if needed. But I do not think it will be needed. There is no ship canal to-day over 28 feet deep.

Mr. JOY. What is the depth of the Suez Canal?

Mr. MENOCAL. Twenty-six feet. It was 22 feet, but it has been gradually deepened. Perhaps now it is 24 feet throughout. We have estimated a depth of 28 feet at the level of the sea, and it can be dredged and made deeper later on, if necessary, when the traffic requires it. Except as to the dredging in the river, the canal is 30 feet in depth. To increase the depth afterwards would not be expensive.

Mr. JOY. It has been stated publicly that during the greater part of the year there is a calm existing on both sides of the canal.

Mr. MENOCAL. That is not the case. There is a constant breeze from Greytown to Brito. The trade winds never fail in Greytown, nor on the Pacific Coast. They blow right through. The breeze was so strong, and blew so steadily off shore, that we found it difficult to make surveys, for fear of our boats being capsized.

Mr. PATTERSON. Did you accompany the Commission which recently visited the site of this canal?

Mr. MENOCAL. Yes, sir.

Mr. PATTERSON. I would like you to state somewhat in detail what opportunities those gentlemen had for observation and reaching correct conclusions, and wherein they differ from you in their estimates; and if so, why.

Mr. MENOCAL. The Commission was in Nicaragua altogether forty days. Of these forty days, a total of two weeks, more or less, was spent in examining the canal route, or rather the canal route and vicinity. Some places they touched and others they did not. These gentlemen traveled by the most comfortable methods, either through the woods or along the roads, so that they were only two weeks examining the canal from the Atlantic to the Pacific coast. They were detained in Greytown both on the arrival and before leaving.

The CHAIRMAN. Please state just what methods they used.

Mr. MENOCAL. They arrived in Greytown and remained a week waiting for a steamer that was to bring certain outfit for the Commission. They had ordered this outfit, but the Commission arrived before the steamer containing the outfit arrived, and they waited a week for it. They then went up the river and had to transfer in the river from one steamer to another at two different points. They then came to the lake and went to Fort San Carlos. There is only one steamer on the lake, and when they arrived it was not there, and the Commission had to stay two days waiting for this steamer. In those three days they made a trip up the river running south, and they also took a river steamer and went out into the lake and took borings and soundings. They came back to Fort San Carlos and waited for the river steamer. When it arrived they got aboard and went to St. George, on the other side of the lake, where they landed their party and the Commissioners, and went to the capitol to visit the President. Next day, in the evening,

they arrived at Rivas, 3 miles distant, from the lake and there they stayed two or three days hunting horses and other means of transportation to go over the line of the canal. On the morning of the third day they left Rivas and went toward the Pacific Coast to a point 3 miles from Brito and passed the night. Up to this time nothing had been seen of the canal. On the following morning they went to Brito, leaving camp about 7 o'clock a. m. Arriving at Brito they stayed there, and the gentlemen had time to take baths and look around a little. They then came back to the same camp, following more or less the line of the canal. The other days were spent in traveling. The line had been cleared for the Commission from one end to the other.

Mr. PATTERSON. Were any borings made?

Mr. MENOCAL. No, sir. I had instruments at all places to verify everything, and they had some also, but no surveys were made. They continued in this way, traveling 6 or 7 miles a day to the lake, and then went to Rivas for transportation across the lake. After they got across the lake, they went to Fort San Carlos and spent a day waiting for connections, and drifted down the river to Ochoa. At Ochoa they landed in the afternoon of one day about 2 o'clock, and looked around a little, visited the ridge line and the region of the San Carlos basin south of Ochoa. They spent one day going and one day coming back. On the second day they arrived, and the next morning they started on their way across to Greytown. They were six days in that section.

Mr. PATTERSON. If I understand you, no instruments were used except what you furnished.

Mr. MENOCAL. Not by the Commission.

Mr. PATTERSON. And my information further is that in locating the route of this canal by you every part of the line was examined and bored and that you knew exactly what its formation was, and the soil and every kind of material through which you must go in order to make the canal?

Mr. MENOCAL. Yes, sir; I had taken 696 borings.

Mr. PATTERSON. Nothing of that kind was done by this Commission?

Mr. MENOCAL. No, sir.

Mr. PATTERSON. And they had no data, except what they got from you?

Mr. MENOCAL. They had nothing, except the data I furnished. I want to say this to remove misapprehension. I must say that they ran lines around Greytown while they were waiting. Only a part of our instruments were used. After they left Greytown they sent a party back to make a survey of the confluents of two rivers. I will point that out on the large map. As we were about leaving Greytown they sent some of the party to make this examination, and the result fully confirms what had been made previously by me.

Mr. PATTERSON. There are two questions in that connection. Would it not be possible for a board of engineers who were in possession of the maps and profiles, surveys, and all the data with which you are familiar to have made this investigation and report as well in the privacy of an office in Washington as to make report on the cursory kind of examination and survey which they gave?

Mr. MENOCAL. I think so.

Mr. PATTERSON. They simply walked over the country there without aim and without any data further than you furnished?

Mr. MENOCAL. Yes, sir. I had an assistant with me with all the plans, and wherever we touched the line my assistant took the plans, profiles, and borings, and I called their attention to it and asked them to examine the plans. I said: "I want you to satisfy yourselves that

these plans are correct, and I want to show you where the borings were taken." I took them to places where the borings were made, and they saw the core of the rock and the lay of the ground.

Mr. PATTERSON. Does the difference between your estimate of the cost of this canal and the estimate of the Commission grow out of any defect or criticism of your work?

Mr. MENOCAL. No, sir.

Mr. PATTERSON. Or does it involve additional work?

Mr. MENOCAL. There is no criticism of the work, and yet there is some criticism of what they think the work ought to be. The board admits the practicability of the canal as proposed by the company, but they have proposed changes which tend to increase the cost, and which are entirely unnecessary. They say that the channel in the river should not be less than 250 feet wide, and in the lake it should not be less than 300. The company wanted to build a canal economically, which would accommodate the traffic of the world. They wanted to, at the same time, build it for such an amount of money as would pay a reasonable return upon the capital invested. They intended that it could be enlarged when the traffic of the ocean required it.

The CHAIRMAN. With the facilities the board had, how long would it have required to have verified all of your work?

Mr. MENOCAL. Oh, that would have required several years' work and observations if they had attempted to verify the surveys and borings in detail. I told the Commissioners that the surveys and borings had all been carefully made; that I had an accurate record of them all; that a large number of men were employed in the work, and that I had engineers of experience to conduct the work. I was repeatedly told by them that they had no reason to doubt the accuracy of our surveys. I followed them step by step, with profiles and maps and plans, showing the results of the borings and surveys, and called their attention constantly to the different parts of the route, and very frequently invited them to verify those plans, maps, and surveys. It is said that we did not take borings enough at the site of the Ochoa Dam. I think we have. We have taken seventeen borings there, which show only two kinds of material, clay abutments and sand, in the bed of the river. We have penetrated sufficiently to satisfy us that a stone dam there is not practicable, except at enormous cost; that the building of such an expensive dam is unnecessary, and that other methods must be applied in order to obtain the necessary results of impounding the water to the necessary elevation.

Mr. DOOLITTLE. Do you mean a masonry dam?

Mr. MENOCAL. Yes, sir; that such a dam is commercially impracticable. That it could be built, but it would be enormously expensive. Knowing that and satisfying ourselves by the 17 borings at the site of the dam that there was no rock foundation, and that we had only clay hills as abutments and sand in the bed of the river, we arrived at another method for building the dam, which we regard as safer and cheaper, than a masonry dam, and the dam we propose I believe to be indestructible either by floods or earthquakes. This dam is very simple. Having strengthening abutments of clay hills on both sides of the river, the method proposed is merely to dump the stone obtained from that deep excavation into the bed of the river, giving the dam a very large base as compared to the height. That is to say, the height of the dam will be about 60 feet above the bed of the river. I propose to give it a base of about 1,000 feet, composed of large rocks, weighing from 4 to 10 tons deposited in the bed of the river, the voids to be

filled by smaller material, and then an embankment on the upper side of the dam of still smaller material, to make the dam tight, as required to impound the waters of the river. Such a dam will leak, but our object is not to store water, but only to arrest the free flow so as to raise it to a certain elevation. When we have raised the water to that elevation our object is accomplished, and if a portion of the surplus waters percolate through the dam there is no harm done. The dam will eventually become tight. This is inevitable by the silt of the river itself. This is a simple description of what we propose to do. We propose to build that dam contending with the flow of the river. In fact, I believe that the only safe way to build a dam is by contending with the flow of the river, so as to assist us in distributing this material until every stone and every pebble has found a resting place. The Commission has stated in its report that the dam is practicable, but that they propose some modifications; one of which I think is unnecessary but extremely expensive, the other I think will lead to disaster if carried out.

Mr. DOOLITTLE. Is the current of the San Carlos of any assistance in this work?

Mr. MENOCAL. It forms part of the San Juan itself, and we ignore the San Carlos, for the reason that it is already merged in the San Juan and becomes a part of the main river, the dam being 5 miles below the confluence of the two rivers.

Mr. NOONAN. In reply to a question of Mr. Patterson you stated that those Commissioners could compile their report as well from the data which you have as by going over the ground. Don't you think there is some advantage in getting a contour of the country?

Mr. MENOCAL. They did get the contour of the country. None of them had visited the tropics, I believe, and they got an idea of the country and shores. I believe none of them had been south of Key West, and everything was novel to them—the country and vegetation and animals and rivers. Everything was new to them, the rainfalls and the heat of the sun—all this was novel.

Mr. NOONAN. If those men had experience, would it not give them some idea of the cost to travel as they did over the route proposed?

Mr. MENOCAL. Yes, sir; I think so.

Mr. NOONAN. Without actually surveying?

Mr. MENOCAL. Yes, sir; I think so.

Mr. NOONAN. That is, give them a safe conjecture in regard to it?

Mr. MENOCAL. Yes, sir; observation, no matter how short the time, will enable one to arrive at conclusions that can not well be reached by other methods.

Mr. NOONAN. My object in asking you this question was to have you qualify your answer to the question of Mr. Patterson. My question was what might be called a leading question.

Mr. MENOCAL. I think this, that some of the examinations were very superficial. I was speaking only of this particular case when I answered Mr. Patterson. I had only in mind the superficial examination made by this board. In order to be materially assisted by the inspection of the ground the engineers ought to have been there in the rainy and dry seasons—to be there at different times of the year—as the rainfall varies very much. An inspection of two weeks in either the rainy season or the dry season, or the season intermediate between the two, gives only a very superficial knowledge, which is misleading, because they judge from the conditions they have been able to observe in that short length of time. This statement is verified by the great divergence of opinion between the members of the Board and practical

contractors, who had spent several months in Nicaragua both in the rainy season and in the dry season. These gentlemen went there for the purpose of getting the necessary information to enable them to bid for the work, when the company was getting ready to commence the construction, and they spent six or eight months—even more than that—in that country. They offered to build this railroad through the swamps, which is regarded as the most difficult part of the line, and over a portion of the hilly country also, to see how they could handle the men, how much it would cost them, and what work they could get out of the men. Contractors from Chicago and from California were there for quite a long time, and they built this railroad, as I have said, for about one-half the estimated cost. These gentlemen, after gaining all this experience, are now ready to bid for the whole work of the canal inside of my estimate.

Mr. JOY. You say they are ready to bid for this work inside your estimate?

Mr. MENOCAL. Yes, sir; to build that canal, and these men know what they are talking about. They not only followed every boring we took, and followed the engineers and camped out with the engineers, but then looked into the question of how much work they could get out of a laborer, and volunteered to build that railroad for the cost, with 10 per cent to pay for the clerical work.

Mr. CORLISS. Do I understand you that the contractors are ready to take the contract for this entire work, according to your plan, inside of your estimate of $65,000,000?

Mr. MENOCAL. Yes, sir.

Mr. BENNETT. Those gentlemen would be willing to appear before this committee?

Mr. MENOCAL. Yes, sir; I think so. I have a letter from one of them now, saying that they are willing to take the contract inside of my estimates, for the different parts of the work; or, otherwise, they will take a contract to build the whole canal, bear the entire expense, and run all risks, inside of $100,000,000.

Mr. PATTERSON. The thought I had was this: That while intelligent and educated gentlemen, engineers, might walk or ride through a country and form a general idea of its topography, yet such information, when it came to estimating the cost of a canal, its excavation and the material that would have to be excavated and the amount of the material and all that, is worth but very little.

Mr. MENOCAL. Very little; yes, sir, and may be misleading.

Mr. PATTERSON. And at last it must be based upon the actual surveys, the profiles, and data.

Mr. MENOCAL. Our plans are so complete and perfect—and the Board had to admit that—that any engineer can get a perfect knowledge of the topography of the country by an inspection of these plans and charts. Every boring is marked. In the deep cut we have taken many borings, and at the sites of the locks, I think, 120 borings were made. It was almost unnecessary to bore as much as that, because the materials are uniform.

Mr. BENNETT. Have you a side elevation of the proposed canal?

Mr. MENOCAL. I do not know that I have it here. I will see.

Mr. DOOLITTLE. Before you proceed with that, allow me to ask one question. Please state about what length of time the engineers spent at the Ochoa dam, and tell about the examination that was made there, at the site of the dam.

Mr. MENOCAL. Not any. They did not examine the site of the dam; they passed by it.

Mr. BENNETT. If they passed by such an important piece of work, estimated to cost millions of dollars, without investigating it, what would their investigation amount to?

Mr. MENOCAL. I am not prepared to answer that. I only say they passed by there. I had fixed all their camps so that they would have an opportunity of examining the most important sites, and one of the camps was at the Ochoa Dam itself. They slept there two nights, and, as I said, they went one day to examine the adjacent hills. I had a camp here [exhibiting on map], and six days' provisions, and a number of engineers. They arrived in the afternoon and looked around for half a mile or so and came back to the camp; the next morning they started for the San Carlos ridge line. I sent the boats here to bring them back [exhibiting on the map], and on the following day they found them here and brought them back, and they arrived at the camp about 4 o'clock in the afternoon. Next morning they started to look over the line of the canal and never had any time for an examination of the site of the dam.

Mr. DOOLITTLE. What examination did they make personally of the river from Ochoa to the lake—that is, as to the material?

Mr. MENOCAL. They went up the river in a steamboat, traveling at night occasionally. In the daytime they could see the banks; at night nothing.

Mr. DOOLITTLE. In this report, a considerable sum is added to your estimate on account of supposed rock excavation in the bed of the river.

Mr. MENOCAL. That is due more especially to the larger dimensions proposed by the Board. They do not question our estimates so far as the quality of the material to be removed is concerned, although it is hinted here and there that the borings are not sufficient, but still they think that the material estimated as dredging is dredging and what I estimate as rock is rock. The fact is, that wherever there were indications of rock I estimated it as all rock. In the river the width is estimated at 125 feet, as I said before, and the Board has increased that to 250 feet, and it is estimated at 300 feet in the bends of the river. They have also increased the cost of both the dredging and the rock excavation in the river considerably. The rock excavation has been raised from $3 a cubic yard to $5, and the dredging has been increased by about 50 per cent of my estimates.

Mr. WANGER. They add $1,000,000 for hospital.

Mr. MENOCAL. Yes, sir; we had as many as 2,500 men employed in Nicaragua, and we built hospitals to accommodate all the sick in that length of time, and I believe the cost of the hospitals, outfit, and everything complete did not exceed $25,000. We were very highly complimented by those who visited the canal—English and American officers and engineers—upon our hospital arrangements. I think the hospital was as perfectly conducted and managed as any hospital is in any part of the world—not so luxurious as some, but we had a large staff of officers and all the necessary supplies and comforts for the sick. It did not cost the company, I think, buildings and all, together with instruments and bedding, and all that, more than $40,000. I think that $200,000 will provide for all the hospitals and appliances thereto along the whole line of the canal. Of course, a great deal more can be spent if it is desired to put up luxurious buildings, as was done in Panama. There $4,000,000 were spent for this purpose alone.

Mr. JOY. The Commission say that they deem the building of this dam impracticable on account of the dangerous foundation on which it would have to be built. What have you to say as to the foundation?

Mr. MENOCAL. I think their conclusions, as you will see in the report,

are that the rock-fill dam is practical, but they have added a great deal on account of the methods they propose for strengthening the abutments. They have increased the estimate from $50,000 to $500,000, and have also increased the cost by $1,500,000, providing for a series of sluices in the vicinity of the dam to get rid of the river during the construction of this mound. I call the dam a mound. That is what it is—just a pile of rocks. On account of these sluices they have added $1,500,000.

Mr. CORLISS. That would be a detriment.

Mr. MENOCAL. I regard the estimate of $500,000 for strengthening the dam as a gross exaggeration; and I regard the other estimate of $1,500,000 to take away the flow of the river during the construction of the dam as dangerous and likely to lead to disaster. My proposition is to build this dam with the assistance of the river. Stones will be dumped, as many as are required, and the river will assist us in depositing these stones, until every one of them has obtained a resting place.

Mr. DOOLITTLE. Until a barrier, like one of nature's barriers, is created there.

Mr. MENOCAL. Necessarily. We will continue dumping these stones, and the water will gradually rise, small material filling in the voids. As I have stated, the river itself will aid us in building this great mound across the river. While we are dumping these big rocks in the river, of course we are all the time contending with the flow of the water, and when we have completed the dam we have controlled the element with which we have been contending. But, on the other hand, if you take away the river from this mound and build it free from the water, the result will be that when you bring the river back, and the water acts with a hydraulic head on the dam and the foundations, there will be a sudden settling of the mass. This will take place suddenly, instead of gradually. The mass of stone will sink, a portion be carried away, and the repairs would be very expensive. This is the main point upon which we mainly differ from the board. The board thinks a masonry dam will be better. It can not be brought within a reasonable cost, and I believe this rock-fill dam is the best and cheapest.

Mr. JOY. Where is there to-day existing any dam of considerable dimensions similarly constructed to the dam proposed by you at Ochoa?

Mr. MENOCAL. There are several in India thousands of feet in length and on sandy river beds, not across such an insignificant river as the San Juan, which is insignificant compared with the Ganges or other Indian rivers. The Ganges is a river of enormous flow. Over some of the dams in India over 1,000,000 cubic feet of water flow per second in times of flood, the water running in some cases 20 feet above the weirs. In Nicaragua it is estimated that the greatest flow of water over the dam will be 150,000 cubic feet per second, not much more than a tenth of the flow over the Indian dams; and yet these dams are built in a soft river bed, with soft soil banks. They have stood there for years; not as high as the Ochoa dam. It is only a question of proportion of dimensions. The highest of them in India is perhaps 22 feet. That is the highest I know of. In Nicaragua it will be a little over double that, with the advantage that in building the Nicaragua dam we have all the stone that is required. It is right there. It only has to be blasted and dumped in the river.

Mr. DOOLITTLE. How far from the dam is the stone?

Mr. MENOCAL. About 12 miles. You could not get a better dumping place.

Mr. JOY. At these points, where you propose to erect the locks, have your borings demonstrated that you can find a solid foundation?

Mr. MENOCAL. No question about that. There is not the least doubt about that. At the sites of some of the locks there were as many as a hundred borings made. It is not rock foundation, but hard clay foundation, which is equivalent to soft rock—better, because it is perfectly water-tight.

Mr. CORLISS. Why, in your judgment, did the board feel it necessary to recommend a wider excavation in the river than that planned by yourself?

Mr. MENOCAL. I do not know. Perhaps because the board was familiar with the canals connecting the Great Lakes, and with other similar canals. We propose a ship canal, through which there will pass only 6, 8, or 10 ships a day. They probably had in view canals with which they were familiar. For example, there passed through the Sault Ste. Marie Canal, according to figures for the last season of 231 days, about 17,000,000 tonnage in that time, or at the rate of about 26,000,000 tons a year. The canal was open for navigation 231 days in the last year I have, in which time there passed through about 18,000 vessels, steamers, tugs, ships, scows, etc. There is such competition on the tonnage that passes through that canal that every minute and every mile counts. Passing to the Nicaragua Canal, the traffic there will probably not exceed 10,000,000 tons. The company has never estimated that much or about 7 or 8 ships a day, 2,500 tons average capacity. Instead of saving 50 or 100 miles by the Nicaragua Canal, as is the case with these Great Lakes canals in some cases, there will be a saving of hundreds and thousands of miles, and therefore the loss of a few hours or a few days plays no part whatever in the question of the trip from one point to another. So you see the great difference between the one and the other.

Now, these gentlemen in considering the Nicaragua Canal had in mind the conditions existing in connection with the canals at the Great Lakes. The conditions are entirely different. There is no ship canal to-day that has the dimensions we propose for the Nicaragua Canal. The Suez Canal to-day is not 100 feet wide throughout the whole length. Lately they have commenced to enlarge it, and it is 112 feet for some of its length. The Manchester Canal has just been completed with a width of 120 feet; the Kiel Canal 85 feet. We have proposed 125 feet in the river, 150 feet in the lake, and 100 feet in the rock excavation. This is to be wider than the Kiel Canal and the Suez Canal.

The CHAIRMAN. Would there not be this difference in the canals you have mentioned: They have soft bottom and sides, while here they are made of jagged rocks, which would make greater width necessary?

Mr. MENOCAL. You mean between the lakes? The channel between the lakes is excavated as well. There the vessels pass going at full speed. In the Nicaragua Canal it is not estimated that they will go more than 5 or 6 miles an hour. I have a letter from the chief engineer of the Manchester Canal. I asked him if he thought there was any difficulty of ships passing at all points, with the canal 120 feet wide—5 feet less than I have proposed, in the river, and the same depth in all other portions, except the deep cut—and he tells me that there will be no difficulty whatever in their passing at all times and meeting at all places, at the rate of 6 miles an hour. I have this letter from the chief engineer of the London docks. At any rate, we have numerous basins in the river itself and the artificial basins that we have made, and the traffic can be so regulated that there will be no necessity for passing at all points. It is not intended to pass at all points. It has not been done in the Suez Canal. Why should this be made an exception to all other ship canals in the world?

Mr. JOY. You propose to use the river in place of the canal at Ochoa. What is the sharpest curvature?

Mr. MENOCAL. Three thousand feet.

Mr. JOY. Can one of the large vessels go through without a towboat?

Mr. MENOCAL. Yes, sir; we have the opinion of the experience of naval officers and experienced captains of merchant ships—captains of the Pacific Mail steamers, who have gone over the ground with me. It is their opinion that there will be no difficulty whatever in ships going through. However, in one or two points I have estimated to cut off the bend of the river to a considerable extent.

Mr. BENNETT. Then a ship going through with its own power would not injure it?

Mr. MENOCAL. The sides of the canal are supposed to be lined with stone anyway where the sides are soft.

Mr. JOY. How much distance in the lake do you figure will have to be excavated?

Mr. MENOCAL. Fourteen miles to get a 30-foot depth of water. Now, in regard to this width of the canal. First, the canal is estimated at 120 feet wide. The slopes are estimated at 3 to 1, and in the lake also 3 to 1. Maybe in the lake it will require as much as 5 to 1. If you take a ship drawing 20 feet of water, you will have 180 feet between the banks. You see by the slope there would be 180 instead of 120 feet, and in the lake there would be still more, because the slopes are flat. So, while we have estimated 120 feet, that is only at the bottom, and as the average draft of ships would be about 20 feet and the maximum 25 feet—there are few anywhere to-day more than that—there would be a margin in all cases very much larger than we have proposed.

Mr. JOY. You do not think there will be any danger of the flooding of the sands by the action of the water and by the excavation in the lake itself?

Mr. MENOCAL. No, sir; I do not. There is no current there, and there is no reason why it should. The lake is large and the discharge is comparatively small. The basins are small as compared to the area of the section. Consequently, the current in the lake is imperceptible.

Mr. CORLISS. Would it not have a tendency to lower the level?

Mr. MENOCAL. No, sir; it would be an average of 110 feet above sea level by the Ochoa dam. Necessarily there would be fluctuations. The level would probably fluctuate 3 feet—from 108½ feet to, say, 111½. I do not think the Commission disagrees with me, but they seem to have thought that when I said 110 feet above sea level that I meant this level was permanent. I could not mean anything of the kind, because the lake must fluctuate up and down between the rainy and the dry seasons, and when I said 110 feet I meant the average. It may fall a foot and a half. It may rise a foot and a half above that, yet leaving a greater depth than we have in any ship canal in the world to-day.

A REVIEW OF THE REPORT OF THE BOARD OF ENGINEERS, APPOINTED UNDER ACT OF CONGRESS, TO EXAMINE AND REPORT UPON THE NICARAGUA CANAL PROJECT.

By Civil Engineer A. G. MENOCAL, U. S. N.

To anyone familiar with the project of the interoceanic canal across the American Isthmus, as it is proposed to be constructed by the Maritime Canal Company of Nicaragua, the first and continually prominent

fact that commands attention in considering the report of the Board of Engineers appointed by the United States Government to consider the feasibility, etc., of the enterprise, is that the subject is treated by the company and by the Board from two entirely different and distinct points of view.

The company regards and has treated the project as a business enterprise, with a view to commercial requirements, technical success, and financial results. The Board entirely ignores two of these conditions and considers it from the point of unlimited expenditure without any question as to financial results, and provides beyond commercial requirements of the present for the accommodation of demands that, at the utmost, can only be claimed to be rarely occasional.

The only point on which there is agreement is the entire feasibility of the project. As to this, the claims of the company are conceded by the Board, and any difference that exists as to the methods by which the work may be achieved is measurable by increased cost of construction.

Whether such increase of cost is a necessary factor in the problem is then the question at issue, and that to which I have particularly directed my attention.

In discussing this question it is my purpose to review in the most concise form consistent with the importance of the subject the conclusions set forth in the report, and to show that the numerous changes proposed along the route, from the Atlantic to the Pacific, are the natural result of the premises on which the Board appears to have acted and their insufficient observations, made on a hasty trip through the territory traversed by the canal, which touched the canal route here and there only, as was most convenient to the line of travel followed, and the consequent imperfect knowledge of the physical condi tions, of the problems, and of the amount and character of the work previously done to develop and utilize to the best advantages the natural features of the country, the necessary requirements of the canal proposed to be built by the company, and the provisions and spirit of the concessions under which the canal is to be built.

The canal projected and estimated for by the company is intended to be built and operated by a private corporation, with private capital and as a business enterprise. It is to be large enough to pass safely all the traffic likely to seek the route, but to be constructed economically, so as to pay reasonable returns on the capital invested. There is a marked distinction between such a waterway and an ideal canal, of ideal proportions, built regardless of cost. It is claimed that the canal designed by the company is ample to satisfy the requirements of commerce and larger in its dimensions than any other ship canal built and in actual operation in the world, except, if they can be classed as ship canals, the waterways joining the American lakes, in which the conditions of traffic are peculiar to those localities and entirely different from those pertaining to ocean traffic.

It is quite remarkable that in the numerous changes proposed by the Board there is not one in the line of economy or in the interest of a better canal. On the well-recognized principle that the best engineering consists in obtaining the results desired at the least expense, increase in dimensions of locks, channels, etc., beyond what is actually needed for the safe and commodious passage of ships, which involve enormously increased expense in first cost, can not be accepted as improvements in such a business enterprise as is contemplated by the company.

The Board lays considerable stress on what is claimed to be the insufficiency of the hydraulic and geological data collected by the com-

pany, and dwells at great length on the need of the fullest and most precise information, accurately recorded and carefully studied, of the varying rainfall and floods of the lake and rivers, the gauging of all the water courses concerned, following their variations of volume and velocity throughout their ranges, etc., before engineering works, such as have been proposed for the construction of the canal, can be decided upon; and adds that, even with such data most carefully ascertained, allowance would still have to be made for possibilities occurring at long intervals. This information, the Board says, has not been secured.

The importance of such data in designing and executing the works proposed is fully recognized and the deficiency referred to in the records of the company is admitted; but all practical engineers are aware of the fact that, even in countries of limited and comparatively regular rainfall, the attainment of such information must be the result of many years of persistent, careful investigations, extending over a large area of territory, with numerous permanent points of observation. In a country like Central America, where the range of rainfall in the same locality varies as much as 100 inches from one year to another, and 200 inches or more in the same year between points less than 100 miles apart, theories based upon observations extending over twenty years may be entirely upset the twenty-first. It is a well-known fact that the lowest water level of the Mississippi River and of other large streams in the United States has not yet been established, and that after many years of constant observations and the expenditure of many million dollars in their improvement, the régime of the streams is but approximately known. It is also well known that the works undertaken by the Army engineers for improvement of the navigation of Columbia River, at Cascade Falls, were designed, and construction commenced on them, after many years of careful observations of the rainfall and when the régime of the river was supposed to have been satisfactorily established; yet the flood of 1894 rose several feet above the tops of the works, which, consequently, will have to be raised, at considerable additional cost, to bring them above the new high-water mark. To defer the designing of the Nicaragua Canal until all the precise hydraulic data required by the Board is accurately recorded and the régime of the lake and of the numerous water courses affected by its construction are fully determined would be equivalent to putting off the execution of the work indefinitely.

The concessions granted by the Nicaraguan Government provided, under penalty of forfeiture, that the final surveys for the location of the canal should be completed within eighteen months from the date allowed for commencement, and that the final plans be filed and the work of construction commenced within two and a half years from the date of the grant. The fragmentary hydraulic data obtainable in that short length of time, while the project was in process of development, would have been of no more value in connection with the design of dams, weirs, and other works, than will be the information proposed to be obtained by the Board in the eighteen months, additional surveys recommended.

In the absence of this unattainable exact information the engineer familiar with the topography and varied meteorological conditions of the country must assume generally coordinate conditions on which his works are based, and then to be on the side of safety make liberal allowances for a possible maximum. The work of preparation and actual construction will extend through a number of years, during which valuable data will be secured, to which the works must be adjusted in

their completion. There is no other practical method possible under the circumstances, and with the proper exercise of judgment the work is reduced to a minimum. This method is also much simpler than to go through lengthy, complicated theoretical calculations, based on assumed watersheds, rainfalls, and run-offs, all far from actual conditions, and leading to conclusions worse than valueless, because, to those unfamiliar with the country, they are misleading. In the case of the River San Juan, at Ochoa, it was assumed that the maximum flood might reach 63,000 cubic feet per second, and provisions were made for a discharge of more than double that amount from the basin of the San Juan, with a maximum rise not exceeding 4 feet. The Board has returned from its trip to Nicaragua with the impression that the maximum flood may reach 150,000 cubic feet per second. This estimate is, in my opinion, a rough and excessive guess; but assuming it to be nearer the correct figure than the company's estimate, the problem is reduced to one of detail; that is, to increasing the length of weir crest and sluiceways so as to provide for the estimated additional discharge. That the minimum flow of the River San Juan may be less than 11,390 cubic feet per second, as shown by the gauging of May, 1872, is not disputed, as the lowest level of the river has not been established, but the extraordinary low water of that year is a matter of record recognized by boatmen and those living along the stream, but that the flow may be as little as one-half or one-third that amount is not admitted, and the rough gauging made by the board near the lake in May, 1895, can not be accepted as of sufficient value for comparison.

The maximum fluctuations of the lake level, as near as can be determined from the information obtainable, is about 10 feet. The level 96.6, given by the Board as reported by an engineer in Nicaragua, is inadmissible, as such low lake would practically cut off the flow of the San Juan below Toro Rapids, an event not recorded in the history of the country. The fluctuations of lake level and discharge will be controlled by the Ochoa dam. The flow of the river will be more uniform by reason of enlarged sectional area in the created storage reservoirs and lessened fluctuations of lake level; and with an intelligent management of the sluices and weirs, at both the western and eastern ends of the summit level, there is no reason why the lake should not be maintained within 1½ feet of the assumed 110-foot level, as proposed in the company's plans. With the regimen of the river and lake thus regulated, the flow will be more uniform and far more in excess of the amount required for necessary lockage than has been estimated.

The Board questions the estimate of three-quarter inch per mile slope allowed in the river from the lake to Ochoa, and, without assigning valid reasons or presenting any figures to disprove it, presents an estimated slope of two-tenths feet for this entire distance, based on a discharge of 10,000 feet per second. There is no data at hand on which to base computations conducive to even approximate results, as the constantly varying section of the river and conditions of the banks and the contractions and expansions of the flooded valley at every point will result in variable conditions of flow, which can not now be ascertained. But it is of direct interest to observe, in this connection, that in the section of the river called "Aguas Muertas," between Machuca Rapids and the confluence of the river San Carlos, where for a distance of 18 miles the depth varies from 40 to 80 feet, the slope of the river, for a flow of 11,000 cubic feet, is nearly 1 inch per mile. The sectional area of the river above Machuca Rapids, as modified by the dam,

and exclusive of expansions of the valley where the current will be nil, will not vary materially from the dimensions given for the "Aguas Muertas" section, and it may be fairly estimated that the slope will be about the same. Nearly similar conditions of slope obtain between the lake and Toro Rapids. The estimated slope of three-quarter inch to the mile assumed for the plan of the canal is, therefore, insisted upon as approximately correct until disproved by some substantial reason or by computations not yet submitted by the Board, and the unsupported assertion that the lake level of 110 feet will be extended to Ochoa, and that the dam and embankments should be raised 4 feet by reason thereof is, in my opinion, unwarranted and inadmissible, and the increased cost due to that change should be regarded as an unreasonable addition to the estimates.

The Board attaches considerable importance to retaining the lake level at or above 110, and believes that any fall from that level will be injurious to navigation in the river and canal. There is no foundation for the statement. The canal is projected to be, ultimately, 30 feet deep throughout from ocean to ocean, but in order to reduce first cost of construction the river section and the sea-level sections of the canal have been estimated with a depth of 28 feet, the additional 2 feet to be excavated after the canal is open to traffic. It is claimed that the lake level can be maintained within a range of 3 feet, or within 1½ feet of 110, and the Board does not seem to dispute it. Should the lake fall 18 inches below the 110-foot level the excavated channel in the river will yet have a depth of 26½ feet, or 6 inches more than the Manchester and Suez canals, and the sections of canal in excavation a depth of 28½ feet, or deeper than any ship canal in the world. That is to say, the lake may fall 2 feet below the assumed summit level, 110, and all the sections of the river and canal in excavation will yet remain deeper than any other canal now in successful operation, and there is no apparent reason why this canal should be made deeper than experience has conclusively shown to be sufficient elsewhere.

Owing to lack of time and the pressing need of carefully surveying and developing vast sections of the country not previously examined and entering as important factors into the problem of designing and estimating the cost of the canal, the company was not able to make a new and more detailed survey of the river San Juan before operations were suspended. This omission has not, however, the importance attached to it by the Board. The river had been surveyed by a party of navy officers, specially trained in hydrographic work, under the immediate charge of Lieut. J. W. Miller, acting under the supervision of Commander E. P. Lull, U. S. N., commanding the Government surveying expedition of 1872–1873. The company had the free use of the field notes and original plans of that survey, and there is no reason to doubt the accuracy of the survey or the sufficiency of the estimates based on the same. The compass survey referred to by the Board was set aside, not because it was valueless, as stated in the report, but for the reason that the company had it in contemplation to supplement the Government survey by a thorough and complete survey of the stream and its adjacent valley as far as Ochoa, with numerous cross sections and borings from the lake to Castillo. There being no question, however, as to the entire practicability of that portion of the canal, the engineering force was kept employed in developing other less-known sections of the country and in rectifying the location of the canal and locks, and embankment sites, until a suspension of work on account of financial difficulties found the river work yet undone.

Borings in the bed of the river, where excavations are needed, would have been of much interest and value, but the discrepancy in the estimates due to the omission of such boring may be safely counted on the right side, as excavations at points where rock is known or supposed to exist have been computed and estimated for as all rock. The estimated excavations at the bends of the river are only approximate and are of doubtful necessity, as with perhaps one exception the bends are not so sharp that, in the opinion of experienced navigators, ships can not go around with perfect safety. These excavations, in any case, will be in alluvial formation on the convex side of the bend, of small depth, and anyone familiar with the ground can see at once that no rock will be encountered.

I will now discuss the changes in the design and dimensions of the canal recommended by the Board in order as they appear in the report.

1. Greytown Harbor.—The Board accepts as correct the principles on which the plans proposed for the restoration of the harbor are based, but recommends that the pier and harbor entrance be shifted about one and a half miles to the eastward, on the ground that as located on the plans of the company it is too near the angle formed by the west coast. The change is not regarded as advisable for the following important reasons:

First. The Government of Nicaragua will not assent to it. The canal concession provides that the company shall build one first-class harbor on the coast of Nicaragua at each terminus of the canal, on the Atlantic and Pacific oceans. The first location for the harbor entrance made by the company was several thousand feet to the eastward of the present location, but the Government of Nicaragua insisted on the removal of the proposed breakwater and harbor entrance to the westward, on the ground that the site selected was on disputed territory between that Republic and Costa Rica; and the present location was the result of a compromise on that point between the company and the Government.

Second. The five and four fathom curves lie five-eighths of a mile and one mile respectively west of the pier head as proposed, and therefore ships entering or leaving the harbor will have considerable more leeway than is allowed at the entrance of the best artificial harbors in the world. Ships arriving off Greytown generally anchor to the westward of the proposed pier extended, showing that the objection raised by the Board is not well founded.

Third. The suggested change would increase exposure to the northwest, with consequent agitation at harbor entrance.

Fourth. It would bring the pier and harbor entrance into dangerous proximity to the mouth of the lower branch of the river, with imminent risk of being undermined and destroyed at the root, or of being converted into an artificial island by the scouring of the coast and shifting of the river into a new channel to the west of the pier.

Fifth. It would greatly decrease the area of deposit for the drifting sand arrested by the pier, and consequently involve an unnecessary increase in length of pier.

Sixth. It would involve an unnecessarily enormous increase of cost over present estimates.

Seventh. The advance noted on the west coast line, as reported by the Board, is due to accumulations of the uncontrolled sands drifting westward, which will be completely arrested by the pier, and no apprehension need be felt as to construction and permanency of harbor entrance as proposed in the company's plans.

2. Greytown Harbor to Lock No. 1.—The change of canal location recommended between Greytown and Lock No. 1 is not advisable, for the reason that it would require expensive and dangerous diversions of the River San Juanillo, and interference with the natural drainage of the country, without thereby gaining any material advantage over the present location. Such a line was located by the company and discarded in favor of the one through Benards Lagoon, which is more economical in construction, and leaves the San Juanillo undisturbed. Had the Board visited that section of the canal location it would have obtained some idea of the topography, and have seen that Benards Lagoon is a lagoon only in name; that it is similar in character to the various swamps extending several miles back of Greytown, and that it offers no more difficulty in being cut into with the canal prism than those that have already been dredged through by the company. In the section of canal excavated, the spoil banks have kept the swamp waters from running into the excavation, while percolation through the surrounding sandy soil has had the effect of draining the swamps in the dry season, the water of the canal being maintained at sea level. The apprehension stated in the report as the reason for the proposed change of location—that the material to be excavated through the lagoon may be mud as soft as that met with in building the pile bridge at the confluence of the San Juanillo and the outlet of the lagoon, or rather the Deseado—has no foundation in fact. That mud pocket is formed by the scour of the inflow and outflow of the waters to and from the San Juanillo and the low land to the westward and the lower Deseado Valley, running through the narrow gorge formed by the steep clay banks and deepening the channel of the outlet, a light sedimentary deposit taking the place of the harder material removed.

The same conditions are observed at the Danta and Nicholson crossing in the valley of the San Francisco, and at all other places where the waters of a river run through a narrow clay gorge to and from a large area of low land. The proposed change in the bottom width of the canal from 120 feet to 100 feet is not in the interest either of economy or of a better canal. The first proposition is proved by the estimate of the Board and the second by the experience gained in operating the Manchester Canal, which is, as the proposed Nicaragua Canal, 120 feet wide at bottom. The assertion of the Board that such a width is not sufficient to allow the safe passage of ships traveling in opposite directions is disproved by a late report of the officials of the Manchester Canal to the effect that ships traveling at the rate of 6 miles an hour pass one another at all points without difficulty. The turnouts proposed by the Board have proved a source of annoyance and delay to navigation in the Suez Canal, by reason of frequent grounding of vessels in taking and leaving them, and they should be avoided. It should be observed that with a bottom width of 120 feet and slopes of 3 to 1, as proposed in the plans, ships drawing 20 feet, which may be accepted as the average draft of vessels using the canal, will have a clearance of 180 feet between banks, and with a draft of 25 feet, which may be taken as the maximum, the clearance will be 150 feet, which is much more than the navigable width at those depths in the Manchester Canal, where the slopes are much steeper.

3. Lock No. 1 to east divide.—The Board finds no special mechanical or other engineering difficulties in the design and construction of locks of the lifts proposed in the company's plans, but thinks it would be preferable to have four locks of uniform lift instead of three as proposed. The change would materially increase the original cost and the

operating expenses without gaining any advantage to navigation. Locks of 31, 35, and 40 feet lift, as proposed, conform much better to the topography of the country, will be less expensive in original cost and maintenance, and offer less obstruction to navigation, and therefore the proposed change is not desirable. As to the recommendation that the locks be built 80 feet wide in the chamber, there is no objection to the proposition beyond the increased cost. The width estimated for by the company (70 feet) is, however, quite sufficient for the unimpeded passage of all vessels likely to pass through the canal, and no waterway built as a commercial undertaking can afford to be overloaded with extra cost for the purpose of making provisions for the passage of a few ships afloat of unusual dimensions which may never have occasion to use the canal.

East divide—No definite changes have been proposed in the section adopted for the "eastern divide cut," but it is pointed out that more borings will be needed to determine with precision the exact character and amount of rock to be removed. The cut is short of 3 miles long, and there were 38 borings taken in that distance. Of that number, 22 borings were made with the auger through the overlying clay to the rock, and 16 were made with the diamond drill in the rock, penetrating to the bottom level of the canal. While these borings showed some variation in the consistence of the rock, there is no indication, either in the cores brought up or in the large masses of rock in view at the Falls and in the bed of the Deseado, of stratification, clay seams, or disintegrated material, suggesting the probability, or even possibility, of the sliding of the mass from the sides of the excavation. It is claimed that with the borings taken, averaging one at every 400 feet on the axis of the canal, and with cross sections of the ground at every 100 feet, the computed amount of excavation is as close an approximation to the actual quantity to be removed as is reasonable to expect in an estimate of this kind, and more so than is generally found in original estimates of works of this magnitude. Borings on lines parallel to the axis of the canal would be of interest and of value, especially if the work is to be done by contract; but for the purpose of an estimate, with a large percentage added for contingencies, they are not regarded as essential.

The San Francisco embankments.—The Board finds no insurmountable difficulties in the construction of the embankments in the valley of the San Francisco. Some of them are important engineering works requiring care and skill in their construction, as has always been admitted, but they are accepted as practicable; not, however, without calling attention in three places in the report to the facility with which such a line of embankments could be destroyed through malice or for military purposes, thus blocking the canal or stopping its operation for a considerable length of time. Such a remark might have been more strikingly emphasized by applying it to the locks and other works connected with the canal, and by adding that there is no engineering work in existence to-day which could not be wrecked by a charge of dynamite.

Railroad and telegraph lines.—The company has provided for a single-track railroad between Greytown and Ochoa, and has estimated it at a price per mile sufficiently high to include the necessary sidings, water tanks, and stations, such as are required during construction, but exclusive of such switches and other temporary tracks as may be needed in the vicinity of the works, the cost of which being chargeable to are included in the estimate of the various works to which they pertain. The Board is of the opinion that a double-track road will be needed for the business west of the east end of the divide cut, and

has increased the estimate accordingly. Considering that this road is to be built strictly for construction purposes, and for no other business, it is believed that even if the traffic westward should be as large as the Board assumes, a well built and intelligently managed single-track road will be quite sufficient for the business. The remarkable state of preservation shown (after four years of neglect) by the 11½ miles of road built by the company under adverse circumstances, as regards the physical conditions and the inadequate plant used in construction, is sufficient proof that track maintenance in that country will offer no greater difficulties than in any other country, nor as great.

The Ochoa Dam and San Carlos Ridge.—The report devotes considerable space to the discussion of the proposed Ochoa Dam. It calls attention to the lack of hydraulic data and insufficient borings taken by the company at the sight of the dam. It cites and describes several rock-fill or dry-rubble dams, built on different sections, different plans, for different purposes, and under conditions entirely dissimilar to those existing at Ochoa, which dams have been demolished when overtopped by the impounded waters. It regards as hazardous to undertake the building of such dam without precedent in engineering, with the meager information collected by the company, and closes the discussion with the conclusion that if a dam must be built at Ochoa, and the physical conditions are such that a masonry dam is not practicable there, the Board is of the opinion that a rock-fill dam, such as has been proposed, can be safely built, with certain modifications of the original plan and method of construction suggested in the report. The matter of hydraulic data has already been discussed in this paper and repetition here is unnecessary. As to the borings, it will be sufficient to say that enough of them were made to establish the fact that there is no solid rock ledge within practical distance available for foundations at the site of the dam. That the abutting hills are composed of compact, hard, red clay, with occasional bowlders, and the bottom of the river of sand to considerable depth. Whether the rock lies 100 feet or 200 feet below the river bottom is of little moment as long as it is too deep to admit of being used for the support of the structure.

To continue boring after these facts had been established would have been a waste of time and money, and operations were therefore suspended after seventeen borings had been made. It was evident from the borings that a masonry dam of the height required was not practicable at that point under existing conditions, and either a more suitable site had to be found or a method of construction adopted suitable to the conditions found. Careful investigations showed that there is no practicable site for a dam between Machuca and Ochoa, due principally to the great depth of water in the "Aguas Muertas" section of the river, and that there is but one available site below, about 5 miles from Ochoa, which presents no advantages over the upper site, the physical conditions being practically identical. The site at Ochoa was, therefore, adhered to, and a rock-fill dam was adopted as the only safe and economical solution of the problem. The dams described by the board can not be accepted as parellel cases, and they throw little or no light on the problems in question. They were built of small stones, packed by hand, with steep front and back slopes, and on rock foundations. They were built for the storage of water, were not intended to be overtopped, and as might have been expected were, with one exception, carried away as soon as a large volume of water commenced to flow over their crests. It is quite remarkable that one of the dams described (the Bowman dam) successfully resisted the flow of a considerable volume of water

over its top, a circumstance due, evidently as much as to any other condition, to the larger size of the stone used in its construction. In searching for precedents of rock-fill or dry-rubble dams built on sandy bottom to withstand the flow of large volumes of water over their tops, we will have to look at the irrigation works of India, where such methods of construction have been in practice for many years.

Rough stone weirs exist at the heads of most of the irrigation channels in Misan, which raise the level of the water to the required height, the lowest being 7 feet and the highest 25 feet.

The Mudden weir is 22 feet high and 168 feet at base. As originally constructed it consisted of a mass of rubble, paved with larger stones, the front face with stones 1½ by 1 foot, while the apron was paved with rough stone blocks of about 2 cubic yards each. That this weir should have stood, with but occasional repairs, for a great number of years is quite remarkable, on account of the small stones comprising its mass. It was recently reconstructed, and the original form was retained by the engineer, but a brick-and-mortar wall was introduced against the upper face to prevent the displacement of the small stones.

The weir at the head of the Agra and Soane canals represents a quite usual type of rough weirs built in sandy bottom. This weir is without solid foundations of any kind, resting directly on the sandy bed of the river. Its crest is 10 feet above the river bed and its length 2,575 feet. The flood discharge is as high as 1,300,000 cubic feet per second, the depth of water over the crest in flood discharge being about 10 feet.

The Soane weir is similar to the Agra weir in general construction; it rests on wells sunk from 6 to 8 feet in the sandy bed of the river, three narrow masonry walls being used to keep the small stone in place. Between the walls is a simple stone packing. The upstream slope is 1 on 3, and the downstream slope is 1 on 12. The weir is 12,470 feet long, and the height, including depth of wells, 19.3 feet. Flood discharge, 750,000 cubic feet per second.

The weir at Begewada, in the Kistna Deltaic works, is 3,198 feet long and 15½ feet high above top of foundations, which consist of a double row of walls sunk in the sandy river bed. The flood discharge is 736,000 feet per second, and at the greatest flood the water rose 19½ feet above crest of weir. It will be apparent that such works could not be built in one dry season, and the floods must have passed over them during construction.

Many similar weirs could be cited of about similar dimensions and built on the same conditions and by similar methods as those described above.

Not any of these weirs approach in height the one proposed at Ochoa, but the precedent of rock-fill dams or weirs, built on sandy river beds successfully withstanding the undermining effects of a considerable hydraulic head and the flow over their crests of enormous volumes of water is fully established; all that is needed in the case of Ochoa being to proportion the structure to the height required. The cross walls used in the construction of the weirs in India to prevent the rolling of small stones can safely be dispensed with in this case by using large blocks weighing from five to ten tons in the body of the whole mound, as has been proposed. That these stone blocks will gradually sink in the river-sand bed, as the work progresses, by the scouring action of the increasing head is fully admitted; but if the practical results obtained in India, especially at the Agra weir, and in many brush and timber dams built in sandy rivers in the United States, can be taken as a criterion, the mound at Ochoa will not sink more than 15 feet in

the river bed under a head of 60 feet, the base of the rock mound being not less than 900 feet in length. The Agra weir rests on the bed of the river without foundation of any kind, practically floating on sand, the friction under its long base being solely depended upon to overcome the hydraulic head. That the comparatively small flow of the San Juan will have but little or no effect on the mound during construction is also proved by the experience gained in India, where such enormous floods as cited are discharged over rock-fill weirs. In fact, during the first stage of the work the floods will practically drown the mound, showing scarcely a ripple in the surface. As the work advances the fall will be more clearly defined, but by that time the whole base of the dam should have been laid in place, and the long apron will serve to destroy the force of the fall. That the dam will become tight by the simple action of the sedimentary deposit of the river is beyond dispute, but the small material proposed to be deposited on the upstream face will precipitate that result.

The Board admits the practicability of the dam, with some modifications in the method of construction. The first consists in strengthening the abutments by means of concrete piers sunk with the aid of caissons, and the second, and most important change proposed is to build a series of sluices in the surrounding ridge of the San Carlos basin, by which the whole volume of the river in flood can be diverted from its natural channel when the mound has attained a height of about 50 feet above low-water level, the rest of the dam to be then built to completion practically free from water.

The first proposition involves a mere matter of detail, and while I regard it as practically of no advantage, and therefore extravagantly and unnecessarily expensive, it need not be discussed at length.

The second proposition is, in my opinion, of the greater importance. It would be an element of weakness in method, and if carried out it is most likely to result in at least temporary failure. I claim that the assistance of the river is essentially necessary during construction by the method proposed, in order to obtain a permanent structure. The hydraulic head should be constantly acting on the base to attain and to keep up the maximum scour and the settlement of the whole mass, and the flow will be a powerful and valuable agent in distributing the material over the work in progress, until every block and every pebble has found a final resting place. But if a portion, and the most important part, of the dam is built free from water, it is more than probable that when the whole pressure is brought to bear upon the structure a sudden settlement of the mass will take place; the dam may be breached thereby, and the resulting injury to the work may be very serious, and to say the least, expensive to repair.

If the method of construction recommended by the company's plan is adhered to, there will be no danger in allowing a portion of the river flow to discharge over the dam. If all the parts composing the mound have in their turn successfully stood a proportional share of the full force of the stream acting on the whole mass, there is no good reason to fear that a much reduced flow will endanger stability. However, that is a matter of detail, and the fact that by raising the dam crest above the highest probable water level in the river the stability of the dam is placed beyond all possible contingencies of accident need not be disputed. But I firmly assert that the method I have outlined for building the dam is the safest, as well as the most economical, and that the modifications proposed by the Board are, first, unnecessarily costly, the auxiliary sluices alone being estimated at $1,500,000, and next danger-

ous as regards stability of the structure. With the sluces and weirs proposed by the company, the summit level can be regulated and the surplus waters safely discharged, and if later investigations should show that the probable maximum floods may be greater than have been estimated, additional weir crest can be provided in due time during construction.

The San Juan River.—The Board believes that the channels proposed by the company's plans in the river San Juan and at the east side of the lake, where excavations are needed to obtain the required depth for navigation, viz, 125 feet wide at the bottom in the river section and 150 feet wide in the lake, is altogether too small, and recommends bottom widths of not less than 250 feet in the river and 300 feet in the lake. Such widths of channel are, in my opinion, unnecessary, and at the outset undesirable on account of the enormous increase of cost involved. There is no ship canal in the world of such channel width, with the exception of the canals between the American Great Lakes, if they can be called ship canals, where the conditions of traffic differ entirely from those pertaining to canals built for the accommodation of ocean traffic.

During the season of 1895, of two hundred and thirty-one days, 17,956 vessels passed through the St. Marys Falls Canal, of which 12,495 were steamers, 4,790 sails, and 671 unregistered craft, or an average of 78 vessels per day, with an average tonnage of 935, carrying an aggregate of 15,062,580 registered tonnage, showing an increase of 7,399 vessels and 6,508,145 tons since 1890. With an estimated traffic of 10,000,000 tons, extended over the entire year, and an average tonnage of 2,500 tons, the number of vessels passing through the Nicaragua Canal per day will be 11, as compared to 78 going through the St. Marys Falls Canal, and for a traffic of 6,000,000 tons the number of ships passing through Nicaragua will average less than 7 per day. The conditions of traffic are also entirely dissimilar. In the lake traffic the distances are comparatively short and the competition sharp, and every hour saved and each mile made represents an appreciable item in the profit and loss account for the trip, while ships passing through the Nicaragua Canal will save hundreds of thousands of miles, and days instead of hours, in the length of the voyages, and the loss of a few hours by detention would play no part in the expense of the voyage. The matter of speed is, therefore, of vast importance in lake navigation, but of far less consequence in an interoceanic ship canal. A wide channel, in which steam and sailing vessels and large tows can travel at full speed, and pass one another at all points without hindrance, is necessary in the former case, while at Nicaragua, with a limited number of ships traveling at comparatively low speed, a much more contracted channel will be sufficient to meet requirements, as has been proved by experience in other ship canals.

Pilots and navigators are of the opinion that there will be no difficulty for ships passing each other in the 125-foot channel proposed in the excavated section of the river. With the channel properly marked, vessels traveling in opposite directions can pass each other at many points, and if necessary the traffic can be regulated so that they will meet only on the lake or in the broad and deep expanses of the river. When the traffic through the canal increases to the extent that such arrangement can not be conveniently carried out without undue delay, turn-outs can be excavated at proper places or the channel widened in its entire length. In the meantime it is not a sound business proposition, and surely not good engineering, to load the enterprise at the outset with such enormous unnecessary expense.

Lake Nicaragua.—What has been said of the river channel can be applied with greater force to the lake channel; 150 feet wide at bottom, with slopes of 3 to 1, as estimated in the company's plans, or slopes of 5 to 1, as is quite possible, may be needed on account of the soft nature of the bottom. With such slopes, vessels drawing 20 feet will have a clearance of from 210 to 250 feet between the banks, and for a draft of 25 feet the clearance would be from 180 to 200 feet.

I am of the opinion, therefore, that the width of channel proposed by the company's plans is quite sufficient, and that the changes, involving enormously increased cost of construction, recommended by the board, are unnecessary.

As to the depth of the channels, the company has estimated 28 feet in the river and 30 feet in the lake. It has been contemplated that when the plans are finally carried out the depth will be 30 feet throughout, but in order to open the canal to traffic with no more expense than is necessary to secure free and safe navigation the channels in the river and in the sea-level sections of the canal have been estimated at 28 feet, which is the maximum depth of the deepest ship canal in the world. Attention is called in this connection to an error recently discovered in the quantities of excavation in the upper section of the river estimated for by the company. These quantities were transferred from the Government report of 1885 (the Government surveys of the river having been used by the company), and it now appears that through clerical error, mistaken computations, or misprint in the preparation of that report the quantities estimated fall short of the actual amount of excavation needed, and it is conceded that the estimates must be corrected accordingly. The computations for excavations in the lake, as on other parts of the canal, were made from data of recent careful surveys made by the company and the amounts inserted in the estimates are believed to be absolutely correct. The discrepancy of 417,000 cubic yards of dredging in the lake between the amounts estimated by the company and as computed by the Board must be due either to error in calculation by the Board or to distortion of the paper after much handling and exposure of the plans, the figures of the Board being based on scale measurements along 14 miles of excavation. The error in the river section was detected by the Board while checking the quantities in the company's estimates.

The change suggested in the position of the pier proposed at the entrance of the canal on the west coast of the lake is not regarded as desirable. The proposed piers are intended to assist ships in taking the canal, and not to break the lake waves, which are never sufficiently high to make the least impression on vessels of the size passing through the canal. The correctness of this statement is proved by the safety with which small boats of the rudest construction ply regularly between points on both coasts of the lake, and also by the remarkably good state of preservation of roughly built crib piers of many years' standing at San Jorge and Granada, on the most exposed shore of the lake.

Lake Nicaragua to the Pacific.—The company has carefully located two routes for the section of the canal between the lake and the Pacific. The route estimated for involves the construction of a dam about 70 feet high at La Flor. A deep basin about 5 miles long, created by this dam in the valley of Tola, and three locks to overcome the lake level, extended through the canal to the dam. The alternate route would be wholly in excavation from the lake to Brito, would require four locks of reduced lift, and, while presenting no engineering difficulties, its cost would be considerably more than the basin plan, by reason of increased excavation and one additional lock.

Deep borings with the diamond drill, taken at the site of the dam, show that the uniform rock ledge lies at great depth below the surface of the valley, and that the construction of the high dam originally proposed would involve more serious difficulties than had been anticipated. The basin plan is, however, so attractive and presents so many important advantages to navigation, both as a passing place and as an inner, spacious fresh-water harbor, less than 4 miles from the Pacific, that the company has been reluctant to abandon it in favor of the all-surface route before a more detailed examination of the site has been made, and it is yet confidently expected that in case a high dam proves to be impracticable, one of considerably less height may be safely constructed and the basin plan, with some modifications, retained. Pending final decision in this matter, a temporary earth dam, with concrete core, has been provided for in the company's estimate for the basin-plan route.

The Board regards the result of the borings as conclusive against the high dam, and without giving any consideration to the modified plan with a low-level basin it recommends the low-level canal as the safest. A remarkable change in location is here proposed between the end of the divide cut and Brito, a distance of about 8 miles. That portion of the route located by the company, after the most careful detailed surveys and study of the country traversed, with due regard to previous examinations made by the United States surveying expedition, is set aside, and a paper location on the south side of the Rio Grande is suggested and estimated upon in lieu thereof. The claim that the proposed change in location would save complications in disposing of the insignificant water course Tola has no force whatever, as that creek can be taken into the canal or discharged under it into the Rio Grande at small expense and without inconvenience to navigation or risk of injury to the work. The transfer of the canal from the north to the south side of the Rio Grande would involve considerable increased cost in construction and very serious complications in the diversion of the stream by a long, expensive artificial channel, nearly as large as the canal itself, into Brito Harbor between the canal and the high land to the west. It would also prevent the contemplated change in location of the lower locks toward the hills, when more favorable foundations can be found for it, and the diversion of the Rio Grande directly into the sea, should such a plan be found advisable. In fact, to engineers familiar with the project, it is difficult to find one plausible reason to justify the extraordinary change in location proposed for this section of the route.

Brito Harbor.—In the location and design of the harbor of Brito important changes are also proposed by the Board, and with the same disregard for increased cost manifested throughout the report. It is proper to state in this connection that the harbor has been designed with the only object in view of securing an easy and safe entrance to this canal, and not for commercial purposes. The local business at the entrance of the canal is not expected to be large, and in any case the company would not be justified in providing for it, at a largely increased expense, before the need becomes manifest as a business proposition. With the harbor as designed, several ships can be accommodated in it without interference with the traffic through the canal, and the topography of the vicinity presents ample facilities for enlarging the inner basin by dredging, when it becomes requisite and profitable to do so. The Tola Basin, and especially the lake, will be inland harbors, where the attractive surroundings and healthful climate will offer strong inducements for ships to lie at anchor for repairs, for coaling, or to

replenish their stock of fresh provisions, with the additional advantage that while lying in fresh waters their bottoms will be cleared of barnacles. For these reasons, large harbors at either terminus, beyond what is actually needed for admission to the canal, are not regarded as necessary or advisable from the start.

The proposed harbor of Brito has been located and designed with a view to satisfy the conditions first stated at the least expense, and as laid down has met with the approval of eminent harbor engineers and experienced navigators familiar with that coast. The claim of undue exposure is not substantiated by facts. The harbor of San Juan del Sur, about 8 miles to the east of Brito, but 600 yards deep inside of the rocky points forming the bight, comparatively shallow, with a shelving bottom and a sandy beach, and open on its whole width to the south and southwest, is uniformly smooth and affords safe anchorage for ships, hardly a ripple being ever observed on the sandy beach surrounding it. The prevailing winds on that coast are the "papagallos," blowing from north-northeast to east-northeast, directly offshore, frequently with great violence opposite Lakes Managua and Nicaragua, reaching their maximum force in December and January. They are first felt about 5 or 6 miles offshore and their influence extends 30 or miles from the coast. During the rainy season, from May to November, gales from the west and southwest, called "chubassos," are frequent and at times violent, although of very short duration.

The proposed entrance to Brito Harbor is open only to the south and southeast, which are the least exposed quarters; the prevailing swell will be practically arrested by the west breakwater and its deflection into the harbor prevented by the east jetty, and in view of what takes place at San Juan del Sur, there is absolutely no reason to apprehend any undue agitation in the basin or the breaking of the surf on the west beach of the harbor, as feared by the Board; the ground swells break on the shelving, open beach of the coast, but not in deep waters, and as to long, high waves, it is well known that the swells are scarcely noticeable half a mile from the coast, where ships can in ordinary weather lie with perfect comfort.

The statement that the borings made by the company are too few in number and of too little penetration to determine the underlying materials within the harbor limits is not sustained by the facts. Sixty borings were made in the vicinity, and their penetrations were sufficient to show the character of the material to be removed and the outline of the rock ledge within the harbor limits. There is, it is admitted, some important and necessary data yet to be obtained before the final plans for harbor construction can be completed in all details, and to respond to the degree of precision demanded by the Board, but not generally observed in the first estimate for work of this kind. In this, as in all other works proposed, the company had not yet reached that degree of completeness in its investigations which would warrant final and detail drawings to be made for each and every work proposed, but the vast amount of data accumulated concerning the route has been appreciated by practical engineers and regarded as unusually complete for the formation and first presentation of the canal project, and the estimate of its cost has been considered sufficiently approximate within the limits of the large margin allowed for contingencies.

Additional surveys and examinations.—The additional surveys and other examinations recommended by the Board would add but little, if any, practical value to the data already at hand. The only material result would be a waste of valuable time and money and unnecessary postponement of the work.

The information recommended to be obtained in the vicinity of Brito Harbor would be of value for the preparation of final working drawings, but it is not essential for determining the practicability of the work or its approximate cost. The surveys of Brito and Greytown were made by experienced naval officers, trained in coast-survey work, and are believed to have been made and the work platted correctly.

It will be difficult to find valid reasons for the assertion made in the report that a new location is necessary in the western division from the summit lock, 9½ miles distant from the lake, to the Pacific, following the left bank of the Rio Grande instead of the right bank, as proposed in the present location. No section of the country traversed by the canal has been more thoroughly examined and no portion of the route more carefully located than that between the lake and the Pacific. The low-level route adopted by the company is the result of the most careful study of data thus accumulated and of a perfect knowledge of the country, and the Board admits that it is perfectly practicable, involves no engineering difficulties, and could be built at less cost than the route suggested by them on the south side of the stream. The diversion of the upper Rio Grande, as proposed by the Board in connection with the modified location suggested, can be carried out as well, and better, as it would be less expensive, in connection with the present location, which has the additional important advantage of avoiding long and expensive artificial channels for the diversion of the Rio Grande, with all the dangers and engineering difficulties connected therewith.

The claim for the new location that it would avoid complications in crossing the creek Tola is not deserving of serious consideration, as that insignificant water course can be readily disposed of, either by taking it into the canal, discharging it by means of a small weir into the Rio Grande, or by passing it under the canal directly into the main stream. It is firmly believed that had the board devoted a short time to the examination of the topography of the Tola valley and other physical conditions the change of location suggested would not have received serious consideration. The new surveys recommended in the lake would add no value to the data now on hand. The surveys at the entrance on both sides could not be made with more care or by more competent officers than those employed by the company. The soundings are quite sufficient in number and location for the purpose of estimating the amounts of materials to be excavated. On the west coast, where no borings were made in the lake, the excavation is estimated as wholly in rock, as indicated by the character of the outcrop on the shore, and no change made in the material could add to the estimated cost. On the east side the material to be excavated has been definitely determined.

That the lake is sufficiently deep for free navigation of the largest vessels afloat between points 14 miles from the outlet and about 1,500 feet from the west coast, the limits of the company's surveys, has been established by soundings, and has not yet been questioned. A complete hydrographic chart of the lake will be necessary when the canal is open to traffic in order to properly mark the locations of the best anchorages and the navigable portions of the lake, but the need of such expensive survey at the present stage of the enterprise can not be clearly understood.

As regards the San Juan River, it has been stated before that the company had the free use of the surveys made for the Government by a corps of competent officers under Commander L. P. Lull, United States Navy, in 1872–73. There is nothing to suggest the belief that

any material changes have taken place in the channel since that date, or that a new survey under the direction of the board would add much of practical value for the purpose of approximately estimating the amount of excavations required. Borings, it is admitted, would be of interest and value, but are not regarded so essential as the board seems to believe. Where rock is known or suspected to exist the excavation has been estimated as entirely in rock, and an examination of the river bed and banks would readily satisfy an engineer or contractor that there is no rock where dredgeable material has been estimated for.

One week's exploration of the river and adjacent valley would probably have been sufficient to satisfy the board that there are no practicable dam sites between Machuca and Ochoa, first, on account of the great depth of water in that section of the river, and second, on account of the prohibitory cost of canalization involved. There is a dam site some 5 miles below Ochoa, but it presents no advantage over the present location. Below that point there is no eligible site either for a high or a low dam. The region of the Serapiqui, as well as all others below Ochoa, has been carefully examined by the Government surveying parties and by the engineers of the company, and the impracticability of a dam in that section of the river fully determined. A casual examination of the topography in the vicinity of the river would remove all doubts on that point. An inspection of the sketch showing the result of the explorations made under the direction of the board in the region of the Serapiqui fails to show the least ground for encouragement as regards the possibility of finding a practicable line by which the flow of the combined San Juan and Serapiqui rivers could be checked in that vicinity. I see in the sketch but a confirmation of my examinations of that locality and of the utter impracticability of the scheme. The exploration in search of dam sites from the Serapiqui to the San Juanillo, and as far as Greytown, could be made in a few hours from the deck of a steamboat sufficiently to convince a practical engineer of the hopelessness of the scheme. But allowing, for the sake of argument, that such dam sites could be found, the canalization of the river by a series of low dams would be impracticable if for no other reason than because of the rapid accumulation of sand, which would soon fill up the channel of the river in the various reaches, and the mere suggestion of the scheme shows a complete lack of knowledge of existing physical conditions.

The Board recommends that from Ochoa to Greytown hydraulic and other data be gathered and studied before final location and construction plans can be decided upon, and that alternative plans, where such suggest themselves, must be investigated with equal thoroughness for comparison and selection. This question of additional hydraulic data has been already discussed in this paper, and the reasons against their necessity are equally applicable in the present instance. As to alternative plans, all those giving indications of possible practicability have been carefully examined, and the present location is the result of most thorough investigations and a complete knowledge of the country.

The completion of the flowage line of the San Francisco basins on the north side of the canal, and the measurement of the watersheds of the several streams, would lead to no practical results. The concession gives the company the right to occupy all the lands flooded by their work free of cost, and consequently the actual area submerged in the expansion and contraction of the basin is a matter of but little concern to either the company or to the Government of Nicaragua, as the lands are of no present value.

The watershed of the streams draining into the basin as a whole is

known with an approximation to accuracy sufficient for all practical purposes. An actual measurement of the catchment basin would certainly be interesting, and of some value in admitting of closer computation of the amount of surplus waters to be discharged over weirs and through sluices; but, as in all such cases, large allowances must be made for a possible maximum. The neat calculation, based on the precise watersheds, measured at considerable expense of time and money and at a time when the enterprise can least stand it, would be of no more value than a close approximation easily arrived at from the data on hand.

The Board has evidently been misinformed regarding the conditions existing at Benard Lagoon, and it is to be regretted that, with such erroneous impression as is manifested in the discussion of that portion of the route, it did not take the trouble to visit the canal route in that region. Such an inspection would have shown that the so-called lagoon does not differ in physical characteristics from the other swamps between Greytown and Lock No. 1. The location eastward and avoiding Benard Lagoon, recommended by the Board, was made by the company and afterwards abandoned on account of increased cost, and more particularly because it would involve a long, expensive, and dangerous diversion of the San Juanillo River. The disturbance of the natural drainage and the diversion through an alluvial formation of such a large stream, in close proximity to the excavated canal, should be avoided if possible, and in this case there is no need of it. The statements that there have been no borings over a portion of the sea-level canal and no explorations made of the depth and other difficulties to be apprehended in the endeavor to traverse the Benard Lagoon are incorrect.

Between Greytown and the eastern end of the divide cut, 80 borings were made, penetrating to the bottom grade of the canal, of which 40 borings were made over the sea-level portion of the canal, the average distance between borings being about 1,000 feet. Considering the uniform character of the material and the fact that all the sea-level section is dredgeable, these are more than sufficient for a close estimate. In addition to the above, there were 121 borings made at the sites of locks Nos. 1, 2, and 3, in the same portion of the route. Altogether, 696 borings have been made by the company, of which 66 were made with the diamond drill, and numerous samples of the materials met with could have been seen by the board at the company's office if desired. Of that number, 103 borings were made on the lower route from Ochoa to Greytown, as to the location of which reference will be made hereafter. The company could not have anticipated the views of the Board in this matter, but it has done all that was believed to be necessary for the purpose of arriving at a close estimate of cost. Further repeated references to borings, to the gauging of streams, and to other hydraulic data in the report need no further remark, as all these questions have been fully discussed already.

The Board, disregarding or ignoring all that has been done before the present route was adopted, recommends a resurvey or reexamination to be made of the entire matter of the choice of route for the eastern division. Nothing could lead to a more unwarranted waste of a large sum of money. Reference has already been made to the utter impracticibility of a canalization of the San Juan below the San Carlos, as suggested by the Board. In this connection attention is called to the statement on page 84 of the report, to the effect that the volcanic sand brought down by the river San Carlos from the volcanic range in Costa Rica, where that river has its sources, has been intermittent in

character and variable in amount, and for sometime past has been suspended entirely. The first proposition is, of course, correct, as the sand brought down by the river is proportional in amount to the rainfall in its watershed and consequent floods, and intermittently corresponding to the frequency of the floods. The second proposition has, however, no foundation in fact, and there is nothing to even suggest it, as the waters of the San Carlos in flood are loaded to full capacity with sedimentary matter, which in turn is partly carried down by the San Juan to the sea, and partly builds numerous shoals and sand banks in its channel. Any hope for a canalization of the San Juan River below the San Carlos, based on such erroneous theory, if for no other reasons, is unworthy of consideration.

The Board also recommends a resurvey of what is called the lower route on the north side and close to the bank of the San Juan from Ochoa to the San Juanillo, and thence to Greytown. This route has been surveyed three times: First, by Colonel Childs; secondly, by the United States surveying expedition under Commander Lull; and third, by the Canal Company. The last was a careful location, cross sectioned and bored along the whole length. From the accumulated data a project was completed sufficiently accurate and in detail for purposes of comparison with the present route. After consideration of all the engineering difficulties due to floods in the San Juan, and the crossings of the San Francisco and numerous other streams draining the vast and hilly watershed north of San Juan from Ochoa to the Sarapiqui, as well as to increased length of canal and greater cost, the route was abandoned in favor of the present one, as the more economical and the safer of the two. All the above data is in possession of the company. The statement that no idea can be formed as to the seriousness of the above objections until all the streams affecting the building of the canal have been gauged and their regimen known, involves a postponement of the solution of the problem for an indefinite length of time, as the regimen of the streams can be said to be known for practical purposes only after many years of constant observations, and then only approximately. Acting on the usual method of approximations adopted in such cases, the difficulties have been carefully considered by the company and found to be so serious as to warrant the abandonment of the route. It would be interesting to know whether the Board contemplates other changes of location beyond these above noted, but it can be safely stated that the whole subject has been so thoroughly examined by the company that the field for investigation may be regarded as exhausted, and any attempt to find a route other than those already surveyed and considered will end only in waste of time and money. Extensive explorations have been made on both the south and the north sides of the San Juan, of which records were not kept, as they showed no indications of possible improvement on what was already known.

As to minor changes of detail in the present route, there may be a small margin for improvement, but not of material importance. When work was suspended in Nicaragua the company had in the field several parties of engineers engaged in making surveys with a view to minor changes in details. The four-lock system, suggested by the Board in lieu of the three locks proposed by the company's plans in the eastern division, had already received consideration and was discarded. The plan and record of that change can be found in the company's records.

Notwithstanding the opinions of the Board, the Canal Company claims to have fully complied with all the conditions requisite to a practical estimate of the cost of constructing a navigable ship canal

across the territory of the State of Nicaragua, in compliance with the conditions and requirements of its concession.

If its gauging of streams, and other data, concerning rainfall, etc., are not so extended and complete as are pronounced necessary by the Board, it is because they are entirely sufficient, and all that is requisite for a sufficiently proximate estimate of the cost of such a canal as is proposed to be constructed by the company—a canal in every way sufficient for the transit of 20,000,000 tons of traffic.

It is the company's records which show the maximum rainfall at Greytown, 297 inches in one year, quoted by the Board, and that fact is openly stated in the company's publications, demonstrating that even the most extreme known conditions have been recognized in the preparation of the company's estimates.

It remains to consider briefly and in their consecutive order the conclusions submitted by the Board at page 85 et seq. of their report.

"1. Greytown Harbor:" Apart from technical objections to the change proposed, already stated, the concessions and the unwillingness of the Nicaraguan Government to allow the terminal ports of the canal to be located other than on Nicaraguan territory are prohibitory of the change proposed, inasmuch as the canal can only be constructed by the use of the San Juan River and Lake Nicaragua, which are under Nicaraguan sovereignty.

"2. Canal Greytown to Lock No. 1:" The proposition of the Board is neither in the interest of economy nor of practical advantage, but is of practical disadvantage, as has been shown.

"3. Lock No. 1 to end of Summit Level at Lock No. 3:" The multiplication of the number of locks is immaterial in itself, but it is objectionable for lack of desirable sites, and on the ground of increased expense, and because such increase is not necessary, as has been shown.

"4. Eastern Divide Cut Data:" The only objection to the Board's suggestion on this point is the consequent delay and the unnecessary increase of expenditure, the company's data being all that is practically necessary.

"5. San Francisco Basins:" The suggestions under this head are in the line of unnecessary increase of cost as has been shown. That of wreckage is a remote possibility which exists in every great public work, and there is no reason why it should have greater force in this case than in others.

"6. Ochoa Dam:" It has been shown that a suitable site for a masonry dam on the San Juan River can not be found, and that a rock-fill dam is the only alternative. The Board admits the feasibility of construction of such a dam. The use of such dams in India, over the crest of which water flows in volume far in excess of even the Board's largest estimate of the flood flow of the San Juan has been shown, and is conclusive assurance of the permanency of such a dam at Ochoa when constructed in the manner proposed.

"7. San Carlos Ridge."

"8. San Juan River, Ochoa to Lake."

"9. Lake Nicaragua."

Are all suggestions involving unneccessary delay and increase of expenditure. Any accumulation of data beyond what the company already possesses, and which may modify the final development of its plans, may and will be accumulated as the work progresses, all as has been shown.

"10. The Lajas Rio Grande route:" The possibility of an alternative location for the La Flor dam is recognized and provided for in the com-

pany's plans. The suggestion of the change of the location of the canal route is objectionable not only on the ground of increased cost, but because of engineering difficulties, avoidable by the company's location, as has been shown.

"11. Brito Harbor:" The suggestions indicate superficial observation of existing conditions. They involve increase of cost for no adequate reason, and unnecessary and disadvantageous changes in plan.

GENERAL SUGGESTIONS.

"12:" Objectionable, on ground that as a commercial undertaking it is unnecessary to charge the enterprise with providing excess of capacity for accommodation of the transit of the very few war vessels of the excessive dimensions mentioned.

"13 and 14:" Objectionable, as involving unnecessary delay. Provisions are made in the company's plans for extreme conditions, and, therefore, the accumulation of data only necessary to completion may progress as the work is carried on.

"15 and 16:" Objectionable, as involving unnecessary delay. Such investigation has been most thoroughly and completely made by the company, as has been shown.

"17:" Immaterial.

"18:" Assertion unwarranted by practical experience."

"19:" Admitted.

"20, 21, and 22:" Depend upon the accuracy of the Board's conclusions, which are questioned as hereinbefore.

COST OF WORK AND ESTIMATES.

In fixing the unit of prices for an estimate of cost of the canal, the Board has been influenced by the controlling impressions received in its hurried trip, made under many difficulties, through a country and in a climate entirely new to it, and has adopted the same extravagant methods and conclusions prevalent throughout the report.

The effect of the climate and rainfall in the execution of the works proposed are greatly magnified, and the conclusions arrived at are at variance with practical results attained both by the canal company and by experienced contractors in doing work at Nicaragua.

It is admitted in the report that a sufficient supply of unskilled labor can be obtained from Central America and the West Indies, especially from Jamaica; that under good management the Jamaica negroes are industrious and fairly effective and their wages only about one-half as much as in the United States, but that the efficiency of the laborers is much less in proportion. It is also admitted that under complete police control and subjected to judicious sanitary regulations there will be no more sickness than occurs on public works in many parts of the United States. The Board, however, finds a concurrence of opinion among those who have had experience in the management of construction work in Central America that the cost of work, due to inefficient labor and unfavorable location, is about twice as much as in the United States.

Attention is invited in this connection to the practical results accomplished by responsible and experienced contractors who have spent considerable time in Nicaragua at all seasons of the year, and knowing the route of the canal thoroughly constructed 11½ miles of railroad for the company, in order to better study the health of the country and the question of the supply of labor for the construction of the canal.

There can scarcely be a more unhealthful piece of work in the entire

canal than that section of the railroad constructed from Greytown 10 miles across the swamps to the higher ground beyond. More than half the men employed worked in the swamps, in water from their knees to their shoulders, ten hours a day, doing hard work, and not always having proper food; and yet out of about 1,000 laborers employed by the contractor for seven months only 2 died of disease. The men did not stop work on account of the rain, but worked steadily through the rainy season, without protection while at work, except two half days during the seven months, and at the end of that time they were in as good health as at the beginning, or even better. Most of the men were Jamaica negroes, but there were also two or three hundred native Nicaraguans and Costa Ricans and a few negroes from the United States. The contractors therefore concluded that the matter of health, as affecting the difficulty and cost of construction of the canal, need hardly be considered more than in estimating the cost of work in almost any part of the United States. One party of the contractors had previously had considerable experience in building the railroad from San Jose to Guatemala City, in Central America. They expressed themselves satisfied that a constant force of 15,000 men, or more, could be had on the eastern end of the work from the island of Jamaica alone. These men are good at task work, and are fairly good in large gangs under foremen. A small number of engine drivers, excavators, and steam-drill men, stokers, etc., can be had from the same sources, also a good many rough masons and carpenters.

The cost of the 10 miles of road built by the contractors was $32,411.18 per mile, including material, labor, subsistence, and contractors' profit of 10 per cent. The ties and rails were imported from the United States and landed at Greytown under many difficulties and at considerable cost. The actual cost was, therefore, a little over one-half the estimated cost of $60,000 per mile allowed in the company's estimate. That the road was thoroughly built is shown by the fact that, after four years of complete neglect, the work was found by the Board in a remarkably good state of preservation, with the exception of the ties that need renewing.

These contractors, with a full knowledge of the country and of all the borings made on the route of the canal, are of the opinion that "the work can be done on the whole canal for about the unit prices estimated by the chief engineer and give the contractors fair profit," and they are ready to contract under bonds to do the work on that basis.

The work done by the company, such as telegraph lines, grubbing, and clearing and dredging, has also cost less than the estimate. The dredging was done with an incomplete and, in some respects, unsuitable plant, and its cost, exclusive of deterioratian of plant, but including all other charges, was 11 cents per cubic yard, the estimated cost being 20 cents.

There seems to be no good reason for the statement that the machinery used will be of but little value after the construction of the canal, that hardly any of it will be worth removal, and its entire cost would therefore be charged to canal construction, making the plant charge higher than usual. With the canal finished and open to traffic and a railroad parallel to it, there is no reason why the plant could not be transported to any part of the world where there may be a demand for it, at the same or less cost of transportation than in the United States. The dredging plant used in Panama for several years was transferred to Greytown in good working order, and the whole plant of the Panama

Canal could have been shipped to Nicaragua without much trouble and at small cost. However, it is quite likely that contractors in bidding for work on the canal would figure but little on future returns from the sale of the plant used in the work, and it may well be doubted that the contractors for the Chicago Drainage Canal, with the experience gained at Suez, and Manchester, and other similar works, expect any proceeds on the completion of their contracts from the sale of the special machinery and other appliances used in the works, except as scrap.

UNIT PRICES.

Dredging is being done in the harbor of Mobile to the amount of many million yards, the material deposited 6 miles at sea for 7 cents per cubic yard, and the contractors appear to be prosperous. In Far Rockaway, where the material has been deposited by pipes as far as 4 miles from the dredges, it costs from 4 to 6 cents per cubic yard. On the coast of England, dredging at the harbor entrances costs from 5 to 8 cents per cubic yard. The dredging done by the company in Nicaragua, with an incomplete and unsuitable plant, cost, as has been already stated, 11 cents per cubic yard.

The Board estimates dredging in Nicaragua at 20, 25, and 30 cents, which is not only enormously in excess of the cost elsewhere, as shown above, but also of work actually done in Nicaragua, and of prices at which bids for the work by responsible contractors have been made to the company.

In the earth and rock excavation the company's estimates are from 66 to 78 per cent higher than the cost of similar work at the Chicago Drainage Canal; the Board's estimate is 150 per cent higher.

Mr. Thomas A. Edison writes from Orange, N. J., under date December 18, 1895, stating that at his works, at Edison, N. J., with present appliances, the total cost of ore for drilling, blasting, loading, and delivery at the crushing plant, including all materials, labor, coal, repairs, etc., is 19.17 cents per ton (2,240 pounds), the average distance from the quarry to the mill being about 2,000 feet. The pieces are taken out as large as possible, not to exceed 5 tons, and he adds that, with the appliances the company is now putting in the cranes for loading the ore into the skips, and with the plant working at full capacity (5,000 tons per twenty hours), he fully expects to deliver the ore at crushing plant for from 12 to 14 cents per ton, and probably less.

The ore weighs about 190 pounds per cubic foot. The canal rock would weigh from 150 to 160 pounds per cubic foot, and Mr. Edison thinks that, with the appliances at Edison, N. J., it should be mined, loaded, and delivered on the bank for about 25 cents per cubic yard. On this basis the canal estimate for rock excavation would be from four to five times the actual cost of similar work in this country, and the Board's estimate from five to eight times larger.

Mr. Edison says that they blow out several thousand tons at each blast, and try to get the pieces as large as possible, not exceeding 5 tons, as with his appliances a man can load a 5-ton piece as quickly as one weighing 500 pounds.

The same methods should be employed at Nicaragua, and the additional cost of 50 cents per cubic yard estimated by the Board for the stone to be used in the rock-fill dam is entirely unnecessary, especially if the rock excavation and the dam are built under one management, as they should be, as it would then be in the interest of the contractor to blow out and select the material suitable for the dam.

Considering that the cost of loading the stone on the cars and of hauling it to the dump are included in cost per cubic yard of excavation, and that the railroad is the property of the company, it seems that the charge of 1 cent per ton per mile for transportation to dam is entirely unreasonable.

The Board's estimate for rock excavation under water is excessive. The rock blasts well, much better than the stratified limestone in the St. Marys River, and there is no reason why the cost of plant in Nicaragua should be 50 per cent greater nor the pay roll double. At any rate, the amount of rock to be removed is large and the plant is simple and comparatively inexpensive. As to the pay roll, it was shown during the progress of the work in Nicaragua that the company could get all the skilled mechanics needed for about the ruling wages in New York, and ordinary mechanics for much less.

The Board estimates concrete at $9.50 per yard, based on the cost of concrete for lock construction at Hennepin Canal. By investigating the subject somewhat further the Board would have found that in the construction of the concrete locks in the Coosa River, Alabama, 20,000 cubic yards of Portland cement concrete have been laid, and up to the close of the fiscal year ending June 30, 1895, the average cost per cubic yard, including material, labor, engineering, and supervision, has been $4.57\frac{3}{10}$, or about one-half the cost of concrete in the Hennepin Canal locks, used by the Board as the basis for its estimate. Other conditions in this same work are worthy of note in this connection. Portland cement, used in the Coosa dam, cost $2.48 per barrel. The best quality can be contracted for free of duty, in Nicaragua, at $1.60 to $1.70 per barrel. The work is done by negro labor, paid for at $1 for a day of eight hours, or $12\frac{1}{2}$ cents per hour, under climatic conditions more trying than those of Nicaragua. In Nicaragua the negro works ten hours to the day and his wages and cost of subsistence amount to about 85 cents per day, say, $8\frac{1}{2}$ cents per hour.

Portland cement will be delivered at Nicaragua free of duty, the stone and sand can be had for the cost of transportation over the company's railroad, and as to the effect of rain on the cost of the work, the whole structure can be protected by temporary sheds, and that difficulty entirely obviated. The average price of $6 per cubic yard for concrete in locks in the company's estimate is ample, and responsible contractors in New York are ready to make contracts under bonds to do the work at that price.

The prices for metal work, estimated by the company, are too high. The material can be had from Europe and all the work done at less cost than in the United States.

As to the sluices and weirs there is no reason for changing the company's estimates, which are regarded as ample to meet the requirements. It has been stated that the $11\frac{1}{2}$ miles of railroad built by the company through the most difficult portion of the line with insufficient plant and dealing with serious difficulties in landing the material cost at the rate of $32,411.18 per mile. The company has estimated the balance of the road to be built on the east side at $50,000 per mile, including turn-outs, switches, tanks, and temporary stations. The Board has estimated for a double-track road at $100,000 per mile, which is not regarded as necessary.

In the western division the company has estimated for a single-track narrow-gauge road to conform with the Nicaragua Railroad. The Board estimates for a double-track standard-gauge railroad, which is not needed for construction work and would be objectionable to the Nicaraguan Government as not conformable to their present system.

It is firmly believed that the company's unit prices for the works proposed are quite sufficient, and that the Board's increased cost of the work is unwarranted and is contradicted by known facts at hand and the fact that responsible contractors familiar with the country and the route of the canal are prepared to enter into contracts for building the whole work at about the company's estimated cost.

STATEMENT OF COL. JAMES ANDREWS.

Mr. Andrews said:

Mr. CHAIRMAN AND GENTLEMEN: I appear before you as a private citizen. I have thought and studied a great deal over this problem. It is somewhat in my line. I have spent my life on public works. I am here to protest most earnestly against this Government being saddled with the cost of an enterprise to carry on which money enough can not be raised from individuals to pay for the engineering. That gives it a very bad aspect. One point I will call your attention to, which it seems to me is a vital one and I do not think has been alluded to, is the question of location. You take that map and go to England and ask the shipowners and the public there where they would locate a crossing across the American Isthmus, and they would say Nicaragua—everyone of them—because it would suit their business exactly and would be to the detriment and injury of American sea commerce.

Mr. DOOLITTLE. My understanding was that Colonel Andrews is interested in the Tehuantepec Railroad, and that he would address himself to that subject.

Mr. ANDREWS. I do not understand that that has any standing here. I am connected with that railroad, have been for many years, and will be glad to answer any questions that may be put in regard to it.

Mr. CORLISS. I think we should hear any objections to the Nicaraguan Canal scheme which Colonel Andrews may have to offer.

Mr. PATTERSON. I think so, too.

Mr. ANDREWS. I often hear of the Suez Canal as compared with the Nicaragua and Panama canals and with other canals. Allow me to say that there is no such thing as a canal at Suez. I have been there. There is no canal. There is a salt-water ditch at the sea level; not a rock in the canal as big as a bean; not a dam in it. Compare the location of the proposed Nicaragua Canal with a country in which there is never exceeding 2 inches of rainfall. There are no slides, no washing, except a little sand drifted in by the winds. Compare that with building a canal through a mountainous country, and as regards safety for the ships passing through the Suez Canal, with either of these proposed canals. It is absurd! It is ridiculous! This must stand on its own merits. The Suez Canal is through a sand drift, drifted by the winds, with the deepest cut 48 feet deep—pure sand. During my trip through there we met seven steamers. We never met one that we did not see go aground before we got out of sight of her. There was not a ship in that trip that went three-quarters of a mile without grounding.

Had it been a rock bottom, such as the proposed Nicaragua Canal, she would never have gotten another foot. No steamship, no iron ship especially, will go into a rock canal unless timber-cushioned in some way to save her from grinding along the rocks. She can not do it. You would rip her open from stem to stern, and every sea captain knows it. It can be lined up, but here is a proposed plan with perpendicular

sides from the water down to the bottom, blasted out; no estimate made for smoothing and polishing the sides. You must assume it is left as the powder will leave it. You can not steer one of these ships in such a canal. The least puff of wind takes her from side to side; sets her swaying. Let a man stand on one of the docks at New York and see one of our big ships making a landing. When she gets within 10 or 20 feet of the dock it takes her a quarter of an hour for fear of hurting herself, and then she comes up against a pine log—not a rock. I tell you, gentlemen, a canal down there is a fearful undertaking.

Another point. The Suez Canal has ruined the English sailing ships; driven them off of the sea. Dig a canal where the American ship can not go, partly on account of the winds and on account of the expense of towing her, and the cheap English tramp steamer would go in there and would drive out all American ships. Never a single sailing ship has gone through the Suez Canal for the same reasons.

Mr. BENNETT. An ocean vessel or other vessel has wooden protectors. Would they not be available in the Nicaragua Canal?

Mr. ANDREWS. They hang small, little buffers over the sides.

Mr. BENNETT. Is that not enough?

Mr. ANDREWS. No, sir; they are loose. They would not save the bottom or the bilge, or the lower part of the ship. She would have to be encased with timber from the bottom up to go through a rock canal, especially if she is an iron ship. Now, our merchant marine to-day, all told, is 6,600 and odd seagoing vessels; that is, they had this number a few years ago. Four hundred and twenty of those only are steamers. The balance are sailing ships. Dig a canal where the English tramp and ship steamer can go through, and away go all your sailing ships; they are driven off of the ocean. The only trade left for our large clipper ships is the Pacific grain trade, going around Cape Horn. Now, I say any policy that will give the advantage to the cheap English steamer will drive them out of that trade, and you had better study the matter seriously or you will find you have ruined what little seagoing marine we have, and given a monopoly to the Englishman, who is laughing in his sleeve and waiting for it. The French Government took the risk and dug out the Suez ditch at a cost of over $90,000,000. John Bull stepped in and carried off seven-eighths of all the tonnage. He gobbled up the whole thing. The French have not added one steamer to their commercial marine; not one.

Now, if you do not study it seriously you will probably find you have done the same thing for the States, so far as foreign traffic is concerned. The Englishmen will come in there, having steamers by the thousand. They go wherever they can get a cargo. The grant by Nicaragua to this Government says specifically that all nations shall be on an equality; that there shall be no favoritism given. All ships that pay the toll shall be free to go through. The United States will build it and not use it. It seems to me foolish and very dangerous—taking all the risks and getting hardly any benefits. It is a monster undertaking. The idea of expending this money some 2,000 miles away when we have lots of places to put it; lots of them, without going there! Let individuals dig all the canals they wish. I see by the papers and otherwise that the United States ought to gobble up, monopolize this crossing. Why, the world would be against any such thing—would not permit it. The Nicaraguan Government has sense enough to say you shall not do it; that it shall be as open as the ocean to the world's traffic. You can not monopolize it in any way. You can furnish the money, and the matter of cost in dollars is not very important; whether it is a hun-

dred million or five hundred million, I believe the United States could stand it.

I see by reading the papers here that this bill provides for a capital of $300,000,000. The engineers estimate $60,000,000. There is $150,000,000 of stock and $150,000,000 of bonds. Three hundred million dollars for a work to cost less than $60,000,000! Something very queer there! I am no lawyer, but I can find nothing in this bill or any of these bills that have been before you for seven or eight years that shows any fixed quantity or stability. There is a grab of $4,500,000 that is to be taken out and paid to the gentlemen in New York. One gives $10,000,000 of paid-up stock, another $1,000,000. There is something strange in that; something unreliable; something you ought to get to the bottom of before you recommend such a bill. One of them provides for an issue of $75,000,000 stock and $75,000,000 bonds. Another of $150,000,000 stock and $150,000,000 bonds. Which is right, or are any of them right? I do not believe any of them are near right from my own experience. As I have said, I have spent my life in these works. The Manchester Canal, with which I am familiar, cost $77,000,000, built in the heart of England, with the most modern machinery that could be applied, runs up the Mersey Valley 30 miles, over the Mersey to Manchester—$77,000,000—and they are in debt, and last year it fell behind. Its revenues did not pay its working expenses. I have left that paper in my room. I got it from Benjamin Baker a week ago.

Mr. PATTERSON. Through what kind of a country does this canal run?

Mr. ANDREWS. A beautiful country.

Mr. PATTERSON. Is it a rocky country?

Mr. ANDREWS. Partially; sandstone; mostly soil.

Mr. PATTERSON. What kind of ships?

Mr. ANDREWS. Mostly steamers—small steamers. One of these steamers a few months ago—I forget her name; I have it somewhere—going down went into one of the locks with a little too much speed and took the gates out with her. I say, a canal proposed across the American isthmus, with its dangers from floods, rainfalls, earthquakes, and other natural phenomena there, no human being could estimate the cost of maintaining or guaranteeing its maintenance for one week. The slightest injury to one of the locks and you are gone up. Every foot of the canal is worthless until it is repaired. The same with the dams. And there are no such dams as proposed here—in India or anywhere else. These gentlemen who have been severely criticised here this morning of course could not stand by and have borings made, but they sensibly say so and recommend an appropriation big enough to send down a commission with ample equipments and give them two years to make these tests. Then you will know what you are doing. Now, it is guesswork; but they do some good guessing.

On page 77 of the report, coming to the proposed dam where borings had been made to 228 feet, on which no engineer of experience would found a dam or a lock. That is one, and if that is so—I have no doubt of it, because they did not make the borings—that is the key to the entire canal scheme, unless they get another location entirely. One bad dam, only one, or one badly founded lock would ruin the whole project. You catch a lot of ships bound for that canal, whether they have crossed the ocean or are on the way; they find a lock out of order. They are not provisioned or equipped to go around Cape Horn. They will have to go home, and I do not think they will ever go back to that canal again, even after it is repaired. It is a huge, monstrous undertaking. Money

will do it with plenty of time, but it is a fearful undertaking in its magnitude to construct and a much more fearful one to maintain. It must work Sundays and Saturdays, day and night, or else it will be "dammed" without using rocks. Now, if there is any precedent anywhere for work of this kind, I would like to know where the precedent is. I will go and investigate it if there is such a precedent. I have never been able to find one in all my readings and travels.

Mr. PATTERSON. Are you a practical engineer?

Mr. ANDREWS. Sort of self-educated. I have been in many big works. I built the jetties at the mouth of the Mississippi River and the masonry of the St. Louis Bridge; sunk those piers, one of them 112 feet below the surface, that weighed 44,000 tons. I have done work of that kind all my life. I have had hard, practical experience. I have had to hoe my own row in that respect, and that is where a man gets lessons. I tell you, too, with water as an enemy you have an enemy that never stops working; it never tires. Start a small leak and it will get bigger.

Mr. PATTERSON. Do I understand that there is no instance in the world where there is a canal excavated through rock that is used by large sea-going vessels?

Mr. ANDREWS. Not one that I have ever heard of or seen, and I have traveled, as I say, in almost every country—with the late Captain Eads all through Russia and the countries over there. We never found a single instance of that kind. There are some canals through which vessels of from 30 to 40 tons may pass, drawn by mules, where they may have rock banks, but never where a ship has gone through a canal with rock sides and rock bottom, and a ship drawing within a foot or two of all the water in it; never one such instance. If there is such an instance, I would like to know where it is.

Mr. PATTERSON. Will you name one, Mr. Menocal?

Mr. MENOCAL. The Manchester Canal is more than half rock excavation, and there are ships of over 5,000 tons that pass through it. It is more than half rock, and with less depth than is proposed for the Nicaragua Canal. The gentleman may have been there. I have been there for two years and am acquainted with the facts.

Mr. ANDREWS. Yes, sir; and it is taken out as smooth as a plastered wall.

Mr. MENOCAL. The question of locks, it seems to me, should not be discussed. The one lock can be passed without a minute's delay.

Mr. ANDREWS. A lock with 16 feet lift only.

Mr. MENOCAL. Two hundred and thirty-one days without a minute's delay, and it has been in operation since 1880. I think all the delay in that lock in that time has been a few hours, by reason of an accident which happened once to one of the valves. When I say about two hundred and thirty-one days, remember that 18,000 vessels went through it that year. That will give you an idea of how many had to pass in fourteen years, day and night.

Mr. PATTERSON. What is the width?

Mr. MENOCAL. Sixty and 80 feet. The one dam there is 60 feet wide, and that is stone.

Mr. ANDREWS. Of cut stone.

Mr. MENOCAL. I think the locks ought not to be discussed. With regard to rock excavation, I will say that more than one-half of the Manchester Canal is solid rock; nothing but rock from the surface of the ground to the bottom.

Mr. ANDREWS. I will give you what was given to me in a letter.

There were but two ships last year, prior to their last report, that went up to Manchester and got cargoes for foreign countries. There were nothing but small boats, except these two foreign ships, that went up that canal in one year. That is the state of facts, and they crawl and creep along there. There is no current. As I said, the canal is excavated to a considerable extent through red sandstone and is exceedingly smooth. Of course, ships can go into a lock, but those locks have but 16 feet lift, instead of 45 or 50 feet. They are much safer and less liable to give way from the huge mass of water and pressure in these enormous locks. They are not subject to big rainfalls or to slides. Here are hundreds of feet of hillsides slipping down into these canals. One cart load of rock there, and a ship may run onto it in the night and stop there until a dredge boat is brought to take it up.

It is surrounded with so many difficulties that no private individuals will put their money in it. I can not see why the Government should be asked to do it. Let them build it. Let individuals build a dozen canals; but why saddle a thing of that kind, that individuals are afraid of, on the people of the United States? That is a mystery. It is such a grand thing and so cheap, and so easy to construct! Lots of capital ought to go into it if those are facts. If they are not facts, private individuals will not put their money into it. Do as the French are doing at Panama—not with the aid of the French Government. We are met every day with the threat that if the American Government does not put this thing through immediately, England will take it up. If that is not enough to make old man Monroe turn over in his grave, I do not know what will. England come over and dig a canal? Not much. John Bull will wait for Americans to do it, and then send his steamers through.

Where are we going to get our share of it? We will get it in dividends. We will never send a ship through there in competition unless there is a tariff—some way of giving our ships an advantage over John Bull. He can not interfere with our coast trade, but in foreign trade, where there is open competition, the cheapest man will get the freight every time. Now, I say some scheme ought to be devised by which a sailing ship, of which we have over 6,000, can fight for a living against the English steamer. Give them a chance. Put them on an equality. But the laws here prohibit that. The sailing ship is to get no cheaper rate of toll, the American ship no cheaper tolls, unless they ignore the concessions. All are to be on the same footing. There is to be no transfer of the lands granted or of the franchises to any foreign Government or other power. No doubt you have read it.

There is no use in my taking up your time to read these clauses, but yet, if I understand it, the United States Government is admitted, substantially, the owner. They are to get the majority of the stock. You buy a majority of the stock, and the property is yours, as I understand it. There is some kind of a hocus-pocus process of that kind going through, I believe, and then what good will it do them after they buy it if they have to let the Englishmen use it. You must get a monopoly of it. Keep an army there if necessary. It is to be the world's highway, open to every nation and to all people, on a big, broad scale. Now, I can not for the life of me understand why they come here and ask the United States Government to tax the people to the amount of hundreds of millions to dig a canal that there are still some private individuals in. Let them dig it for themselves, gentlemen. I have no doubt you can send a man down there and buy out Nicaragua bodily for $200,000 or $300,000 and then build the canal yourself.

Mr. BENNETT. I object to that going in the record.

Mr. ANDREWS. I mean buying the right of way.

Mr. BENNETT. I object to any such criticism of a friendly Government.

Mr. ANDREWS. All right.

The CHAIRMAN. It is not criticism by anybody but this gentleman. I do not see any objection to it.

Mr. ANDREWS. I think the right of way can be obtained there. There was $100,000 paid for the right of way. I think another $100,000 would get it for the United States Government alone without buying out this one that individuals have had in hand for several years. That is what I mean, and the Governments there I think are deserving of fair treatment. They are poor and weak. But why they should be trampled on and their restrictions ignored is what I can not understand. I do not think the English language can be clearer than this clause where they say that this shall not be transferred. If you will excuse me, I will read:

ARTICLE 7. The present cession shall be transferrable only to such company or companies as may be organized for the purpose of constructing or operating the canal, and in no case to foreign Governments or to foreign public powers.

Now, that is a sensible clause for the Nicaraguan Government to put in, I think.

Mr. WANGER. Is that the American report?

Mr. ANDREWS. It is in the Senate report here—Mr. Sherman's report of 1894 from the Senate committee. Now, these are conditions put in by the Government of Costa Rica. Nicaragua has a similar restriction and conditions to prevent its transfer. It says none of the lands shall be transferred, none of the right of way, etc. But these things are all before you, gentlemen. I do not wish to take up your time with those, but I think they are worthy of close study and examination; but see what you are doing before you put this thing out of your power and out of your reach. That Commission, I presume, were honest people; I presume so. I do not know any of them. They went over this route in a rapid manner, got their data largely from the maps, plans, and that given by the company's engineers, and they point out a number of things here that I think all the civil engineers in the United States of practical experience will back up and say are right.

There is a good deal of difference between practice and theory, especially in these large works. It is so easy to figure up so many cubic yards and say how much it will cost per cubic yard. If it is dry work upon the face of the earth it can be well estimated, but sink foundations down below the water level, with water coming in on you, I do not know how any man can estimate the cost of keeping that dry at all until he gets his foundations in. A dam must have a water-tight bottom over its whole area able to stand the pressure. It must not start leaking. If it does, that leak will keep on increasing, and I do not know how you will repair it except to tear it out. But I say these leaks will always be a menace to constant, steady navigation, so great that I think it will always deter private capital. If not, let individual capital build it. We will get all the benefit in that way just as much as if the Government built it, if all nations are treated alike and put on the same footing. And the danger is, gentlemen, if I am right, and as a matter of common sense, first and foremost, the lack of winds there. I have a statement here from the late Lieutenant Maury, the most eminent authority that ever wrote on the subject, stating that if through some convulsion in the neighborhood of Panama, 400 miles of Nicaragua, a gap were opened through that isthmus as wide as the Strait of Dover—20 miles—no sailing ship would ever avail herself of it on

account of the lack of winds and on account of the tropical currents in the Caribbean Sea.

Mr. PATTERSON. My information is, Colonel Andrews, that those conditions do not exist at Greytown and Brito.

Mr. ANDREWS. Not to the same extent. I have printed letters from Commodore Selfridge and three or four others saying that the winds there are very uncertain. There are several months in the year of what the sailors call "doldrums"—sudden gusts of wind from all points of the compass in which a sailing ship may be drifting around for months unless she can pay for towage, and towage down there is very expensive, and it would be very dangerous to tow a ship through into the lakes and out of the lakes and through the canal and through these deep cuts. A wooden sailing ship I am sure would not go through.

Mr. DOOLITTLE. Don't you know that Lieutenant Maury says that these conditions do not apply to Nicaragua, but do apply to Panama?

Mr. ANDREWS. No, sir; I do not so understand it.

Mr. DOOLITTLE. If you read it, you will see he says so.

Mr. ANDREWS. I say it becomes less and less as you come up north, but still a sailing ship will have a very uncertain voyage if she enters even near Nicaragua during certain seasons of the year. At other times of the year they can get along pretty well. But leaving that aside, she can not afford to pay for towage. Her crew would be idle during the time the vessel was towed, and another crew would have to be employed. I have seen some of that in New Orleans. When we finished the jetties work there the English steamers commenced coming in there by the dozen, and they are doing it every day, and the sailing ship has been driven out. The trade is monopolized now by the English cheap steamers, because of the cost of towage against the sailing ship up and down the river.

Mr. DOOLITTLE. Would not the building of this canal stimulate the building of steamships in the United States?

Mr. ANDREWS. I think not, as long as the competition with the European steamer is not hampered so as to give the advantage to the American ship.

Mr. DOOLITTLE. But the tendency would be, would it not, to stimulate the building of steamers?

Mr. ANDREWS. Not unless our steamers could be built at a price to compete with the English steamer, because there has been and is competition; no protection to the American steamer, except on our coast trade. On the foreign trade, wheat going from San Francisco to Europe, we can not give the steamer any protection.

Mr. DOOLITTLE. What steamers is that grain carried in now?

Mr. ANDREWS. They are largely American ships—large clipper ships.

Mr. DOOLITTLE. Don't you know that out of more than eighty ships that left Puget Sound, wheat laden, and a considerable larger number from Portland, there was not 3 per cent of American sailing ships?

Mr. ANDREWS. I have no doubt of that, but bad as that is it is the only trade left. There are no sailing ships now between our Eastern States and Europe. They can not compete; and it is going to be the same there. I think you will aggravate the evil if you adopt and carry out such a plan as the one proposed. I am satisfied, however, that a method can be adopted that will put the sailing ship on an equality with the steamer.

Mr. DOOLITTLE. What is our proportion of sailing ships compared with the English?

Mr. ANDREWS. I can not answer that. I can only give you the statistics of a few years ago, when our sea marine consisted of 6,000 and

odd ships of all sizes and kinds. Out of that number only 420 were steamers. I think the same condition exists yet, and if you want to stimulate the American commercial marine you are not going to do it by letting the English ship come in. We ought to have steamers, but unfortunately we have not, and can not get them. We can beat the world building these fine, big clipper ships. No nation can compete with us. We have the timber and materials for building these ships cheaper than they can be built anywhere in the world. But we have not reached the point where we can build the steamer as cheap as England can build it and in Europe. Now, I think it will be a serious mistake to cripple what little shipping we have and stimulate what shipping England has, but this plan if carried out would certainly do that very thing. I think this phase of the subject is worthy of your most profound thought and study and examination. If we can get across from the Gulf of Mexico that is the American route. Let us send all the trade into the Gulf of Mexico. I think the United States would be justified in going to war to prevent the building of either of these canals provided you can get a transit from the Gulf of Mexico across into the Pacific, easily protected and cheap. Now, I am not here to advocate that, because it has no standing before you, but I will say that if any of you wish any information in regard to this proposed plan I shall be glad to give it to the best of my ability.

Mr. DOOLITTLE. You refer to the Tehuantepec Ship Railway?

Mr. ANDREWS. Yes, sir; in which I have been interested for many years, from its beginning.

Mr. WANGER. Located where?

Mr. ANDREWS. (Points out route on map.) Direct from the mouth of the Mississippi River.

Mr. PATTERSON. What is the distance?

Mr. ANDREWS. One hundred and thirty-two miles, and the highest summit is 730 feet, or about 200 feet higher than the Washington Monument. The surveys have all been perfectly made; nine hundred thousand and some odd dollars have been expended in the surveys. It has been surveyed until not an inch of ground will have to be gone over again.

Mr. PATTERSON. This is to be a ship canal?

Mr. ANDREWS. Purely a ship canal, built big enough to hold a modern dry dock on wheels, taking it across there on straight lines. I have hundreds of certificates of its practicability from the ablest mechanical shipbuilding engineers in the world, from our own country and England.

Mr. JOY. What is to hinder this railway from being built?

Mr. ANDREWS. The sole spirit of it was the late Captain Eads. While struggling to get it on its feet he died. Then the few of us who were left got Mr. Windom to take the presidency of the company and help us to go on with it. He was thoroughly embarked in that when he died. We then got Mr. Thau, vice-president of the Pennsylvania Railroad, to take hold of it. He invested largely and we were progressing well when he also died; and the fact is, now there are hardly any of the promoters left. Of late, however, within the last sixty days, I have met with more encouragement to build it than I have before had.

Mr. DOOLITTLE. You always do when it looks favorable for the Nicaragua Canal.

Mr. ANDREWS. No, sir; the very reverse. When this thing is buried, as I think it ought to be, we will start the ship railway and build it quickly, and there the American ships will get fair treatment, in home or foreign trade.

Mr. PATTERSON. What is the estimated cost of this railway?

Mr. ANDREWS. I would answer in this way: It would depend upon the maximum ship that is to be carried whether we use 6, 8, or 10 rails. For a 6,000-ton ship the cost would be something below $50,000,000. For an 8,000 or 10,000 ton ship it will take two more rails and cost in proportion. The route is exceedingly favorable. The first 53 miles of the route will be as easy to build as through the center of the State of Illinois. It is an open prairie. This 53 miles could be built in a few months, and this would be more than a third of the distance. There are two very heavy fills. The rest of the work is exceedingly light. As to the apparatus, I have estimates from men of experience in this line. We can lift any ship up to 10,000 tons to any height less than 50 feet and put it on a car ready for transportation in twenty minutes at either terminus of the road. I have bona fide bids from these parties, and their letters are printed here in some of these pamphlets I have.

Mr. PATTERSON. I am not advised on the subject. Is there any such railroad in operation?

Mr. ANDREWS. On a small scale; yes, sir. The first railroad ride I ever had in my life was on a ship railway on a small scale. It was a bolder undertaking to construct such a road at that time than it is now. That was a railroad with pine scantling for the rail, a flat bar nailed on it. It ran from Philadelphia to Columbia, a place below Harrisburg. It carried a canal boat; had four cast-iron wheels. At the point mentioned the boat was run into the canal and hauled up the Juniata River to Hollidaysburg, and put on the cars again and hauled over the Alleghany Mountains to Pittsburg. That was a ship railway.

Mr. FLETCHER. What elevation?

Mr. ANDREWS. About 2,500 feet above the sea, over the Alleghany Mountains, very nearly parallel to the Pennsylvania Railroad. There is a boat in Sweden I saw a short time ago. It is small, only 80 feet long. It is provided with four wheels, common railway wheels. The axles run through the hull of the boat. She is a paddle-wheel ferry boat. There was a long, projecting promontory there she had to go around to reach her destination, a city on the other side. They laid a common railroad track, with timber on either side. She runs right in, her momentum carrying her on to the railroad. The engineer gears his machinery, and she travels a mile and a half into the water again. These things are exceedingly common, gentlemen. It is only a railway on a larger scale than we have been accustomed to. All things we have are growing larger and larger.

Mr. DOOLITTLE. That even applies to locks of canals?

Mr. ANDREWS. Yes, sir; and so are the ships you have to handle growing larger; so are railroad bridges and railroads themselves. If you will allow me just a moment I will touch upon this subject, as we have commenced upon it. It is an interesting question. It has been before the House and before the Senate in Captain Eads's time repeatedly. It was referred to the Senate committee for examination and report, and the report was certainly favorable after a most thorough investigation. I would like to be permitted to read this report for you gentlemen's information. On March 6, 1882, the Committee on Commerce of the United States Senate submitted a report, No. 213, first session Forty-seventh Congress, on the then pending bill to incorporate the Interoceanic Ship Railroad Company, the first paragraph of which reads as follows:

The first question the committee considered was as to the practicability of constructing a railway for the purpose of transporting ships and their cargoes. The testimony before the committee conclusively demonstrates the fact that such a rail-

way is entirely practicable, and that loaded vessels can be transported over the same with absolute safety and economy. The committee does not consider it necessary to go into the details of the proposition, but refers to the following testimony upon the subject, given by the most prominent and able engineers and architects in the world.

The subcommittee which took this testimony, upon which this unreserved favorable report was based, consisted of three exceedingly able men to take up such a subject. One of them was Senator Vest, of Missouri; the second was Senator Conger, of Michigan, and, ablest of all, Senator Warner Miller, of New York. They recommended it as most practicable. This matter, gentlemen, has been very thoroughly canvassed.

Mr. DOOLITTLE. What year was that report?

Mr. ANDREWS. The report was made March 6, 1882, from the Committee on Commerce of the United States Senate, first session of the Forty-seventh Congress. It gives the testimony, I suppose, of 100 shipbuilders, dock men, etc. A very popular objection to this is the supposed danger to a ship with a cargo on board in taking her out of the water. Gentlemen, facts, facts are what we want in such matters, not theories. Mr. William F. Buckley, president of the New York Balance Dock, in a letter to Mr. Eads, in 1881, gives the following list of vessels taken out: Ship *Great Victoria*, 2,386 tons; ship *Triumphant*, 2,046 tons; ship *Americana*, 2,054 tons; ship *Hagerstown*, 1,903 tons; ship *S. C. Blanchard*, 1,903 tons; ship *Colorado*, 2,765 tons; the *Rio Grande*, and so on, and steamers *Monarch*, *State of Nevada*, and so on; and then he closes with this:

We do not refuse any class of ships or steamers, even with their coals and cargoes on board, whose length does not exceed the length of the dock. In every case where we have taken up steamers with cargoes it has been done without the least strain or injury to the vessel, but as the rule is to make a charge for cargo they usually come without cargo.

But if they come with cargo they are taken up. Captain Samuels, one of the most noted ship captains to-day, told me he sailed an American packet from New York to Liverpool—the ship *Drignort*. She encountered a severe gale before getting to the Irish coast and sprung a leak, and he said all hands were kept at the pumps for over a week to keep her afloat. And when she got to Liverpool she happened to reach there just at the right time to make one of the docks, and the ship was put right in the dock with her cargo and 6 feet of water in her hold without the slightest injury to the ship. Why, gentlemen, to dock a ship nowadays with or without cargo—it is not necessary to discuss it. The only reason why they are not taken out with their cargoes every day is because their cargoes necessarily add a great deal to their weight, and so it is more expensive; and besides that, the owners generally want the cargo as quickly as possible. But if the ship is in trouble they dock her, cargo and all. There is no danger from that source; none whatever.

I maintain that if there is a possibility of building a ship transit that will carry ships quickly and safely, all sorts and kinds, all on an equality so far as cost is concerned, and that is closer to our own country than any other project, that is the American route. That is what ought to be encouraged. It is near home. It does not come in contact with any doubtful claims, such as the Clayton-Bulwer treaty, that some claim is still in force, by the terms of which it was agreed that neither nation would build a crossing across the Isthmus without the other joining. I do not know whether that is so. But in any case this is the American route. By this route plenty of winds are had. We carry sailing ships and charge so much a ton, and the same as to steamships; and therefore the sailing ship if she can compete will have an opportunity to do it.

COMMITTEE ON INTERSTATE AND FOREIGN COMMERCE,
HOUSE OF REPRESENTATIVES,
Washington, D. C., Friday, April 17, 1896.

The committee met at 11 a. m., Hon. William P. Hepburn in the chair.

STATEMENT OF MR. M. T. ENDICOTT, CIVIL ENGINEER, UNITED STATES NAVY, OF THE BUREAU OF YARDS AND DOCKS, NAVY DEPARTMENT.

The CHAIRMAN. You may take your own course as to the method of making your remarks, and after you have finished your statement the members will ask such questions as suggest themselves. Please state your full name and your present occupation.

Mr. ENDICOTT. My name is Mordecai T. Endicott, civil engineer, United States Navy, consulting engineer of Bureau of Yards and Docks, Navy Department.

The CHAIRMAN. How long have you been in that service?

Mr. ENDICOTT. About twenty-two years.

The CHAIRMAN. What were the more important works in which you have been engaged?

Mr. ENDICOTT. I have been engaged as a mining engineer in the State of Pennsylvania; in bridge and railroad work in Connecticut and Ohio, and work of a general character in the Navy, in the design and construction of dry docks and other public works at the navy-yards and stations.

Mr. STEWART. Have you had any experience in canal construction?

Mr. ENDICOTT. No, sir.

The CHAIRMAN. You were one of the gentlemen appointed by the President as a member of the board to inspect the Nicaraugua Canal, and you made a report to the President?

Mr. ENDICOTT. Yes, sir.

The CHAIRMAN. Please state to the committee what you observed while you were engaged in your duties bearing upon the subject-matter of your appointment.

Mr. ENDICOTT. We were members of a board appointed to visit the route of the proposed Nicaragua Canal, make an examination of it and the plans, and report upon their feasibility, permanence, and cost. We were required to visit the route, and did so in May, 1895. I want to say preliminarily, before stating what we have done, that it appears in the previous testimony before this committee that the examination made by the board was hasty and cursory, and that we did not devote the proper time to an examination of the subject, and therefore the views and judgment of the board on the matter of the canal should not be given full weight. It has been said that we went down there for six weeks and spent only fifteen days on the work. That was stated by Mr. Miller and Mr. Menocal in their testimony. I would like to refer to Mr. Menocal's testimony in that respect, because at the outset I would like to satisfy the members of the committee that we devoted our best efforts to learning all about the canal route that it was possible to learn. I will quote from his testimony, on pages 58 and 59 of your printed record:

Mr. MENOCAL. They arrived in Greytown and remained a week waiting for a steamer that was to bring certain outfit for the Commission. They had ordered this outfit, but the Commission arrived before the steamer containing the outfit arrived,

and they waited a week for it. They then went up the river and had to transfer in the river from one steamer to another at two different points.

We arrived there on the 13th of May, and we left the 21st to go up the river. The day after our arrival, the 14th, we commenced work at once and made an inspection of the harbor and breakwater, also of the canal as far as excavated. Mr. Menocal was with us. The following day, the 15th, we inspected the buildings belonging to the company, the shore line of the harbor and coast to the eastward, and started a surveying party to work surveying. On the 16th we went out over the line of the railway and inspected it to a point 11½ miles distant, between sites of Locks Nos. 1 and 2. On the 17th we inspected the west shore of the coast adjacent to the harbor as far as the Indio River. On the 18th we inspected the Harbor Head Lagoon adjacent. We inspected the dredging plant, and in the evening made an itinerary. The 19th, I think, was Sunday, but was employed in platting of surveys. On the 20th we continued our surveys and made cross sections of the canal as it has been excavated by the company. The days intervening between our arrival and the day we left we are not given credit for. We do not receive credit for anything done during that time.

These statements which I make are extracted from the official minutes of the board, and also from my private diary which I carried in my pocket, and which states what the board did each day. There are seven days of pretty hard work done in the initiative. It is true we waited the arrival of our outfit, but we did this work at the harbor and vicinity, which is of an important character. Perhaps no part of the plan has excited more discussion among engineers than the matter of the possibility of improving and maintaining Greytown Harbor. We made an exhaustive examination of that, also careful surveys, which, as we think, throw great light on the problem, and aided us in arriving at a conclusion as to its improvement.

On May 21 we started up the San Juan River by steamer, and made such observations as we could in regard to the physical features of the river and country, and discussed certain features of possible river navigation. We tied up overnight near the San Carlos River. On May 22 we continued to inspect the river (which from here on is part of the sailing route) to Castillo, and made observations and instrumental measurements as to the high and low water levels of the San Juan River.

It has been stated in Mr. Miller's testimony that the floods rise in the San Juan River 4 to 6 feet, but we found at the site of the Ochoa Dam, where we made observations as to the height of the floods, that they rose 14½ feet at that point and 21 feet at Machuca. We stopped overnight at Castillo.

On the 23d of May we inspected the river from Castillo to Lake Nicaragua. From the time we left San Carlos River we were passing over the route of the canal. I do not mean necessarily the canal as it is to be excavated, but it was part of the sailing line of the canal—a very important portion of the system.

On the 24th of May we examined the Rio Frio, a river which empties into the lake near the San Juan River, the latter receiving a portion of the waters of the former directly. We took the levels of the high and low water marks at this point. We also took soundings in the lake, not only as to the depths, but as to the character of the material, by means of sounding rods, and found its consistency with a view of determining the proper slope of the sides in the 14 miles which are to be excavated at this point.

On May 25 we made current and gauge observations of the San Juan

River. No current or gauge observations had been made by the canal company at that point. Some had been made many years ago by other parties.

May 26 we gauged the outlet of the lake again, and sailed for San Jorge. On May 27 we arrived at San Jorge, having inspected the western part of the sailing route on the lake as we crossed.

On the 28th we visited Managua, incidentally making inquiries about lake levels.

Mr. Menocal says (continuing with May 23):

They then came to the lake and went to Fort San Carlos. There is only one steamer on the lake, and when they arrived it was not there, and the Commission had to stay two days waiting for the steamer. In those three days they made a trip up the river running south, and they also took a river steamer and went out into the lake and took borings and soundings. They came back to Fort San Carlos and waited for the river steamer. When it arrived they got aboard and went to St. George, on the other side of the lake, where they landed and went to the capitol to visit the President. Next day, in the evening, they arrived at Rivas, 3 miles distant, and there they stayed two or three days hunting horses and other means of transportation to go over the line of the canal. On the morning of the third day they left Rivas and went toward the Pacific Coast to a point 3 miles from Brito and passed the night. Up to this time nothing had been seen of the canal. On the following morning they went to Brito, leaving camp about 7 o'clock a. m. Arriving at Brito they stayed there, and the gentlemen had time to take baths and look around a little. They then came back to the same camp, following more or less the line of the canal. The other days were spent in traveling.

Mr. DOOLITTLE. Mr. Menocal stated that he was speaking from memory and not from notes, but he referred us to his written statement as being certain on these points.

Mr. ENDICOTT. I was not aware of that, but I am anxious to show the facts.

Mr. DOOLITTLE. He said he was making this statement from memory.

Mr. ENDICOTT. I would like the privilege of correcting the record in this respect. He states that up to that date nothing had been seen of the canal [reading from diary]:

On May 29, and the morning after our arrival in Rivas, we inspected the canal route, the valley of the Rio Grande, following down the river, striking and examining the line at various points and the site of the La Flor Dam, camping 3 miles from Brito. On May 30, at Brito Harbor and vicinity. Here we studied the coast lines on both sides of the mouth of the Rio Grande, where the canal is to strike the Pacific Ocean; examined into the geological formations and points bearing upon the construction and use of a harbor at this point. We rode down south side of the valley and returned on north side. Examined sites of Lock No. 6 and tidal basin below Lock No. 6, returning to the camp we had left in the morning.

May 31, examined canal line to Locks 4 and 5, and thence to La Flor Dam site, outcroppings, borings, etc.; in afternoon we went up trails through the valley and visited lock site in excavation.

June 1, went over the canal line to lake shore and to site of diversions of Rio Grande, if canal is built in excavation. Examined mouth of Lajas; site of piers, etc.

June 2 (Sunday), party surveying mouth of Lajas, levels of lake. June 3, no work. June 4, no work. June 5, on lake, inspected harbor under lee of Ometepe, taking soundings, etc. June 6, returning by steamer; no work. June 7, arrived at San Carlos; no work beyond observations and views of approaches. June 8, on river, San Carlos to Castillo; observed the navigation from hurricane deck and high-water marks on the border of the river. June 9, from Castillo to Ochoa, observing the navigation, country on banks, etc.; at Ochoa at 11 a. m., camping at site of Ochoa Dam; inspected 1½ miles of canal line and returned over the ridge line, visiting locations of numerous borings. June 10, to south abutment of Ochoa Dam, on opposite side of river, and followed dam and San Carlos ridge line south 7 miles. June 11, 3 miles further on San Carlos Ridge (10 in all), and then to river San Carlos, and back to camp in canoes, via San Carlos and San Juan rivers. June 12, left Ochoa, following embankment line and canal line; inspected locations of guard gates, embankments, borings, etc., and camped by Danta River. June 13, followed canal line, near Florida Lagoon, and embankment line to camp, San Francisco, left bank. June 14, San Francisco to Chanchos, walking over embankment line and returning to camp

by river; in the afternoon, up San Francisco and landed, and walked back over canal line; inspected locations of cuts and other works in vicinity, and gauged streams—San Francisco and Nicholson.

June 15, took canoes to Chanchos, and thence followed embankment line to Camp Carmen on Limpio, about 5 miles; in the afternoon back over canal line. June 16, left Camp Carmen by canal line, and on to Camp Alice on Lindo, 2½ miles; canal in excavation here on. Took breakfast at Camp Alice. Up Deseado, 2 miles, to examine geological formations and matter of possible diversions. June 17, left Camp Alice, crossed Divide, following canal line closely, examined site of Deseado Dam, and Lock No. 3 to south of it. June 18, on to Camp Menocal, over canal line. Left this camp at noon; inspected sites of Lock No. 2 and dams, and reached Camp No. 7 at 2 p. m. Thence to site of Lock No. 3 and dam site, and thence by railroad to Greytown. June 19, took steamer to inspect Colorado mouth of the San Juan River, bar, etc. June 20, examined and surveyed mouth of Colorado, and returning sketched the river to junction with San Juan. June 21, sent surveying party off to Serapiqui River; no work. June 22, lagoon and shore-line surveys, etc., completed. June 23, getting ready to leave. June 24, sailed for Port Limon. Davis spent nine days after June 22 in surveys about Serapiqui.

My record shows that we spent forty-two days in Nicaragua, and of that time thirty-four were spent in an examination of the physical features of the canal route. This is actual fieldwork. I wish to say that we fully realized the importance of the duty imposed upon us; that it was a question of interest, not only to this country, but to the whole world. We felt that we had been highly honored by the President in being selected for this duty, and we went down to Nicaragua with the determination to see all and to learn all we could about the canal route; to study the matter carefully, and to give our best judgment in regard to it.

Mr. STEWART. Did you start out with any preconceived notions as to the feasibility of the canal? Did you have any personal opinion about it?

Mr. ENDICOTT. No, sir; I did not. When we departed from the country a surveying party was left there to make some surveys and to look into the matter of a site for a low dam on the San Juan River below Ochoa. That party spent nine days there after we left for Panama, and that time added to the other would make forty-three days of fieldwork instead of fourteen or fifteen, as credited. The time spent in Costa Rica and Panama was also very important. We learned a great many things about the cost of labor and about the influence of the rains and the climate upon the work which had been done in building the Panama Canal and the Costa Rica railway.

Mr. STEWART. Are not the climatic conditions different in Panama from what they are in Greytown?

Mr. ENDICOTT. There is some difference. The climate is more favorable in Nicaragua. There was very little sickness in connection with the work on the Nicaragua Canal; but I expect when they get into the hills and expose the clay banks the conditions will probably be very different. We found that in Costa Rica and Panama parties experienced very little difficulty until they struck the actual work of construction, when sickness began.

Mr. DOOLITTLE. Is it not a fact that that is always the case when virgin soil is being removed?

Mr. ENDICOTT. Yes, sir; that is generally true.

Mr. STEWART. The plan is favored by you, but your objection is the cost and the unhealthiness of the employment?

Mr. ENDICOTT. We differ as to cost, but I think the plan is not feasible in its present shape. It is not practicable.

Mr. STEWART. Could it be made so if it were modified?

Mr. ENDICOTT. Oh, yes; I am fully satisfied the canal can be built.

Mr. DOOLITTLE. Is it not a mere matter of working out the details?

Mr. ENDICOTT. It is a matter of working out the details, of course. There are some important things underlying it in which I think the company is not quite right.

Several MEMBERS. Tell us what those things are.

Mr. ENDICOTT. Their scheme provides for an interoceanic canal 28 feet deep. The present scheme will give only 24 feet for a large portion of the year, because it is founded upon the supposition of a slope of 4 feet in the river from the lake to Ochoa, and the Ochoa Dam, San Francisco and San Carlos embankments, etc., are regulated in height for a water surface of 106 at Ochoa, and 110 at the lake; and the question is whether they can maintain the lake at 110 feet above sea level. We are satisfied from our investigation and calculations, carefully made, and in which we agree that the work on the San Francisco embankments, the lockage, Ochoa Dam, and San Carlos River embankments must all be raised to maintain a water elevation at Ochoa of 110 feet or more. If not, the water will drop to the level of 106 feet at the lake every dry season.

Mr. STEWART. These calculations are not embraced in your report?

Mr. ENDICOTT. The formula is not.

Mr. STEWART. Would this fall from 28 to 24 feet make a serious objection?

Mr. ENDICOTT. Yes, sir; I think so. You must remember that a part of the San Juan River has rock bottom, and this fall would give navigation only for vessels drawing 22 feet or less of water.

Mr. DOOLITTLE. What is the depth of the Suez Canal?

Mr. ENDICOTT. It was originally 26 feet. It has now been deepened to 29½ feet.

Mr. DOOLITTLE. Was it 26 feet when it was built?

Mr. ENDICOTT. I think so.

Mr. DOOLITTLE. What is the depth of the Manchester Canal?

Mr. ENDICOTT. The Manchester Canal is 26 feet.

Mr. SHERMAN. On page 58 of Mr. Menocal's statement he says the Suez Canal was originally 22 feet deep.

Mr. ENDICOTT. Possibly it was; if so, it has been enlarged twice. The Suez Canal was designed for a larger cross section than was originally given it. It was found that its cost was exceeding the estimates so much that the dimensions were reduced.

Mr. BENNETT. How long did you spend in the immediate vicinity of the Ochoa Dam?

Mr. ENDICOTT. Two days.

Mr. BENNETT. Do you consider that length of time enough to make a proper investigation and enable you to report on the feasibility of a work of such magnitude?

Mr. ENDICOTT. Yes, sir; unless we had gone into extensive surveys or borings. We had not time or money for that. So far as observing the site, the time was sufficient.

Mr. PATTERSON. In the judgment of the Commission, this canal is practicable?

Mr. ENDICOTT. The canal is practicable.

Mr. PATTERSON. And when constructed it would answer all the purposes of commerce which have been attributed to it by its friends?

Mr. ENDICOTT. I think so.

Mr. STEWART. Do you agree with the New York Herald that it would be a feature of weakness in our military or naval status if we should build the Nicaragua Canal?

Mr. ENDICOTT. I think in case of war with a country like Great Britain we might have to blow up the locks and abandon it. I do not think we could hold it against Great Britain.

Mr. DOOLITTLE. If we had strength equal to theirs we could.

Mr. ENDICOTT. I am speaking of the present time.

Mr. STEWART. We are strengthening our naval force?

Mr. ENDICOTT. Yes.

Mr. PATTERSON. You say the Nicaragua Canal is practicable, and when constructed it will answer all the purposes which have been attributed to it by its friends. At what cost, in the judgment of your Commission, can this work be done?

Mr. DOOLITTLE. I would suggest "in accordance with the plans of Mr. Menocal."

Mr. PATTERSON. No; I want his own idea.

Mr. ENDICOTT. The actual construction will cost $133,000,000, not including the interest on the money during construction.

Mr. PATTERSON. You think that with $133,000,000 this Government could construct the Nicaragua Canal, and give a depth of 28 feet, which would answer all purposes of commerce?

Mr. ENDICOTT. I think it would give a depth of 30 feet.

Mr. BENNETT. Thirty feet of navigable water?

Mr. ENDICOTT. A depth of 30 feet of water.

Mr. PATTERSON. Do you think that when this canal is constructed there will be any difficulties in the way of navigation? Do you think that large ships could go through that without difficulty?

Mr. ENDICOTT. If built as recommended by the Board, I think they could.

Mr. PATTERSON. What do you mean?

Mr. ENDICOTT. We have recommended the widening of the prism in the lake. We think there ought to be 250 feet width in the river, while the canal company contemplates only 125. We think that is not enough for the river, because it is much more difficult to navigate a channel of a given width in an open expanse of water than between banks, and in the upper San Juan the excavated channel will have rocky bottom and sides.

Mr. PATTERSON. Would you advise the United States to undertake at once, with the necessary modifications of the Menocal plan, to construct this canal?

Mr. ENDICOTT. If the Government is going into the matter of the building of a canal I would advise it.

Mr. PATTERSON. If the Government is going into the construction of a canal, you would advise us to construct it with the modifications which you propose?

Mr. CORLISS. Do you think it is advisable to go into the construction of a canal?

Mr. ENDICOTT. I think this Government ought to have a waterway between the Atlantic and the Pacific.

Mr. CORLISS. From what point of view?

Mr. ENDICOTT. I think it is important from a military point of view.

Mr. CORLISS. Is there any other point which you think is as desirable or advantageous as the Nicaragua site?

Mr. ENDICOTT. I can not say that I know of any other. One might be found at greater cost, perhaps. I think, in some respects, the Tehuantepec route is an ideal one, but there may be some difficulties of an engineering character to render it very costly. From a strategic point of view it is the better of the two, as it could be more easily defended. It would also be a shorter route for our commerce.

Mr. PATTERSON. Do you think from the mere fact that the excavation is through rock that there would be present any serious obstacles to the navigation of this canal at 30 feet?

Mr. ENDICOTT. Not if it is built of the proper width.

Mr. PATTERSON. It has been argued here forcibly and earnestly by at least one gentleman that this canal, being excavated through rock, it would be practically impossible to navigate it with large steamers. He said that the canal at Manchester is not used by large steamers; that it is impracticable to do so, and we might find that this canal could not be used for the purposes of commerce, as contemplated by its friends. What is your judgment in regard to that?

Mr. ENDICOTT. I think it could be used for the purposes of commerce.

Mr. PATTERSON. You know of no physical difficulties in the way?

Mr. ENDICOTT. No, sir.

Mr. PATTERSON. You have compared the Nicaragua Canal with the Panama route. Is it not a fact that there is less rainfall than in Panama?

Mr. ENDICOTT. Not on the east coast.

Mr. PATTERSON. It is on the west coast?

Mr. ENDICOTT. In the interior.

Mr. PATTERSON. Is it not true that at Panama on either side there is such a calm as would prevent sailing vessels from using that route, whereas at Nicaragua the trade winds prevail, and it could be used both by sailing and steam vessels?

Mr. ENDICOTT. I think so. Nicaragua is more favorable in that respect than Panama for sailing vessels.

Mr. PATTERSON. And notwithstanding the Nicaragua Canal would cost $133,000,000, according to your plan, you believe that, even at that expenditure, it would be the best and cheapest for the Government to adopt?

Mr. ENDICOTT. That is my personal impression. I do not know what it would cost to complete the Panama Canal. They claim it can be done for $100,000,000. I do not know whether that is true or not. We have not looked into that. I think the advantages at Nicaragua are considerable, and such as might outweigh the question of the cost.

The CHAIRMAN. What is the present condition of the work that has been done by the company as you observed it at Greytown—for instance, the harbor works?

Mr. ENDICOTT. The harbor works are in pretty bad condition. The navigation which they once had there is lost by reason of the entrance being destroyed. The pier is in bad condition, and is decayed and worm-eaten.

The CHAIRMAN. Is anything remaining of the work of present value to this enterprise?

Mr. ENDICOTT. Not much. The pier I do not consider of any value.

The CHAIRMAN. Would not the work thus far done have to be removed, in order to give place to that sufficient work that you recommend under your plan?

Mr. ENDICOTT. A considerable part of it would. Under our plan the entrance and a good deal of the work would be abandoned. They have a short section of canal about a mile long, excavated about 16 feet or more, and a portion not quite so deep. This stands in good condition. That, I think, cost less than $100,000. They have some buildings, a hospital and office, and they have some dwellings and some plant, but the plant is in bad shape. I do not think there is much else of value.

The CHAIRMAN. As an engineer, at what would you estimate the present value of all the work done on that enterprise?

Mr. ENDICOTT. Speaking roughly, I should say half a million dollars.

The CHAIRMAN. Did you examine the working plant owned by the company?

Mr. ENDICOTT. Yes, sir.

The CHAIRMAN. Of what does it consist?

Mr. ENDICOTT. It consists of five dredges which they bought from the Panama Canal Company. They are sunk in the harbor, and are in a dilapidated condition. Some of the machinery might be used, but the woodwork is about worthless at the present time. There has been considerable improvement in machinery, which renders this obsolete in a large job of this kind. The tugboats and scows are badly rusted and decayed. They have two or three locomotives in fair condition, and they have 11½ miles of railroad.

The CHAIRMAN. In your estimate of $500,000 do you include the railroad and telepraph line and the locomotives?

Mr. ENDICOTT. Yes, sir; the locomotives are not worth much. Of course, I am speaking roughly.

The CHAIRMAN. At what would you regard the present value of the five dredges?

Mr. ENDICOTT. I do not think they are worth over $150,000—probably not worth that.

The CHAIRMAN. If you had a contract to dredge out that harbor and the canal, where dredging is possible, would you, as an engineer, use those dredges there, in view of the improved implements of that character which are now obtainable?

Mr. ENDICOTT. I think not, for so expensive a job. I think it would pay to abandon them and purchase more improved machinery.

Mr. STEWART (to the chairman). I think it would probably be better to give the value of the work at the time it was completed, because it would be unfair that the company should have that cost estimated when it is in a degenerate condition, as it now stands, because the plant has done considerable work.

The CHAIRMAN. Yet the Government, if it is to become the purchaser, should know what it is going to get.

Mr. PATTERSON. I understand Mr. Stewart to mean that the plant has accomplished a certain amount of work, and we can not estimate the value of the plant as it stands to-day.

Mr. ENDICOTT. Do you mean the value of the plant when work was stopped?

Mr. PATTERSON. Yes, sir.

Mr. ENDICOTT. Running the matter rapidly through my mind, I should say it was probably worth $1,250.000.

Mr. DOOLITTLE. Does that include all the surveys which were run there?

Mr. ENDICOTT. No; it does not include the cost of the surveys.

Mr. DOOLITTLE. Do you know how many miles of line were run by the surveyors?

Mr. ENDICOTT. I have heard they ran something like three or four thousand miles.

Mr. DOOLITTLE. From your knowledge of the country down there and the character of work, what would you say was the value of that?

Mr. ENDICOTT. Probably half a million dollars. It costs a great deal to make surveys extending over a long term in that country.

Mr. PATTERSON. Assuming that the changes which you have in con-

templation are not made, could the canal, as contemplated by its promoters and as outlined by Mr. Menocal, be constructed within the limitation of $65,000,000?

Mr. ENDICOTT. I think not.

Mr. PATTERSON. Then you think that the changes which you have indicated in the report of the commission would amount to the difference between $65,000,000 and $133,000,000?

Mr. ENDICOTT. No, sir.

Mr. PATTERSON. What do you estimate the cost of the changes which you have suggested?

Mr. ENDICOTT. I would like to refer you to Mr. Noble as to that, in order to show where the increased cost is. He has prepared tables showing just where the increases are, and can give it to you more quickly and accurately than I can. For instance, the increase due to errors in the computations of the canal company would amount to about $4,000,000 at their own prices.

Mr. PATTERSON. You have no estimate of it?

Mr. ENDICOTT. I have none. The report we made would show it if it was worked out. Mr. Noble has gone through that.

Mr. PATTERSON. You say there were errors in the calculations as submitted to you?

Mr. ENDICOTT. Yes, sir.

Mr. DOOLITTLE. Of what did they consist?

Mr. ENDICOTT. They made a mistake of a million cubic yards in the rock excavation in the San Juan River. This amounts to $5,000,000 increase in the estimates. They have reduced the price of rock excavation in the river from $5 to $3 in their last estimates, making an increase of $3,000,000, according to their own price. Then they made an error of about one million cubic yards in the dredging in earth in the San Juan River, and an error of about half a million cubic yards of dredging in the lake, which amount to about $4,000,000 at the canal company's prices.

Mr. DOOLITTLE. The amount of material to be removed was not given as it should be?

Mr. ENDICOTT. They made some error.

Mr. DOOLITTLE. More than they made allowance for?

Mr. ENDICOTT. Yes, sir.

Mr. BENNETT. Do you believe, even after your superficial examination, that this investigation was close enough to enable you to estimate the cost of the work for the whole canal?

Mr. ENDICOTT. Approximately. There can not be any exact estimate, because I think that the examinations and surveys of the canal company have not been exhaustive enough to make a close estimate. That is one reason why we recommended additional surveys.

Mr. BENNETT. It might cost some less?

Mr. ENDICOTT. It might cost some less, and it might cost some more.

Mr. BENNETT. Mr. Menocal insists that $70,000,000 would complete it. Do you think that is true, according to Mr. Menocal's plan?

Mr. ENDICOTT. I think not.

Mr. DOOLITTLE. You would not be willing, upon your professional reputation, to state that it could not be built for that?

Mr. ENDICOTT. I do not think it could be built for that.

Mr. DOOLITTLE. Would you be willing to stake your professional reputation on the assertion that it could not be built for that?

Mr. STEWART. He says that the examination was not exhaustive enough to enable him to give an opinion.

Mr. ENDICOTT. I can not say at this moment what part of the increase in estimates was due to increase in quantities, in prices, or to changes; an analysis of our report will show all that.

Mr. ELLETT. Did you make an estimate of the cost of the canal under Mr. Menocal's plans?

Mr. ENDICOTT. I do not think that we stated it separately in the report, but our report shows it in figures. It would show the difference of the cost of the canal by his plans, and by our plans, at our prices, if analyzed. I think Mr. Noble can give that to you. The time was so short that we divided up the work.

The CHAIRMAN. Who is F. W. Bennett?

Mr. ENDICOTT. There is a Mr. Bennett in the employ of the Nicaragua Canal Company. I think he was assistant engineer.

The CHAIRMAN. Was your Commission referred to Mr. Bennett by Mr. Hitchcock for estimates of the cost of the construction of the canal?

Mr. ENDICOTT. I think that we were referred to Mr. Menocal, and Mr. Bennett was in charge of the papers in the New York office.

The CHAIRMAN. Did he write your Commission a letter dated August 29, 1895, in which he gives a statement of the cost of the construction of the canal?

Mr. ENDICOTT. We have a statement of cost, but whether it is from Mr. Bennett or Mr. Menocal I do not remember. I think it was from Mr. Menocal.

The CHAIRMAN. Referring to this paper received from your Commission, I find this statement: 11.5 miles of railroad, costing in the neighborhood of $372,000; rolling stock, $62,000; 727,000 cubic yards of dredging, $80,000; 937 lineal feet of pier, $200,000; jetties, $174,000; 66 miles of telegraph line, $19,000. What other items of construction did you find down there, if any? And if there are any other, give us the cost, approximately, exclusive of these I have read.

Mr. ENDICOTT. I think that covers the actual construction.

The CHAIRMAN. What about buildings?

Mr. ENDICOTT. There are buildings, office, etc.

The CHAIRMAN. What are they worth, approximately?

Mr. ENDICOTT. It would be difficult for me to state what they are worth; probably $100,000.

The CHAIRMAN. What other property did you find there, exclusive of the dredges that you have spoken of?

Mr. ENDICOTT. I think that was about all. There were two or three locomotives, but I do not think there was anything else.

The CHAIRMAN. At what did you estimate the engineering work?

Mr. ENDICOTT. Roughly, half a million dollars.

Mr. PATTERSON. Suppose this question was put to you: Assuming that the Government of the United States greatly desires the construction of an interoceanic canal, and that it was willing to pay as much as $133,000,000 for a canal 30 feet deep, sufficient to float vessels drawing 28 feet of water, and supposing that the Government wanted a canal that would be large enough to answer all the purposes of commerce, would you advise the Congress of the United States—assuming all that—to pass a bill for the construction of this canal?

Mr. ENDICOTT. At once?

Mr. PATTERSON. Yes.

Mr. ENDICOTT. Well, sir, I should not.

Mr. STEWART. Why?

Mr. ENDICOTT. I think it would be wise to delay sufficiently to make more surveys, and examine the field more in detail, with a view to the construction of a canal.

Mr. DOOLITTLE. Could that not be done later, after the bill was passed?

Mr. ENDICOTT. It might be modified, of course.

Mr. PATTERSON. Is your plan predicated upon the apprehension that the cost would exceed $133,000,000?

Mr. ENDICOTT. It might exceed that, and it might not.

Mr. STEWART. Is that the only objection to the prosecution of the work at once?

Mr. ENDICOTT. It might be one objection.

Mr. PATTERSON. From your knowledge of the conditions, with the information now in possession of the Government, and assuming that the Government was willing to pay $133,000,000, you think the cost of the canal might exceed that sum?

Mr. ENDICOTT. Yes, sir.

Mr. STEWART. And yet you are an enthusiast for the canal?

Mr. ENDICOTT. Yes, sir; I think we ought to have a canal. I think there is time to make surveys. We do not say that the surveys should be made by the Government. They can be made by the Government, or by private parties. We simply say that an examination should be made.

Mr. PATTERSON. How long would it take?

Mr. ENDICOTT. It should cover a period of eighteen months, so as to take in two dry seasons.

Mr. PATTERSON. Have you an apprehension, if such surveys were made, that it might demonstrate the impracticability of constructing this canal?

Mr. ENDICOTT. Impracticability? No, sir; I do not fear that.

Mr. PATTERSON. Do you fear that it might demonstrate the necessity of spending more money than $133,000,000?

Mr. ENDICOTT. Yes, sir. The matter of the lake levels affects the whole scheme. The height of the Ochoa Dam, and of the embankments on the San Francisco and San Carlos ridge lines, and of the lockage, to keep the lake up to 110, and the means of limiting its fluctuations all depend upon hydraulic data which we think is not sufficiently at hand. We do not think the project ought to be entered upon without exhausting that field and others.

Mr. STEWART. Has any member of this Commission had any experience in canal building?

Mr. ENDICOTT. Mr. Noble has had experience in the Sault Ste. Marie locks. Whether he has large canal experience I am not advised. He has had a good deal of experience.

Mr. STEWART. Is not the reputation of Mr. Menocal high?

Mr. ENDICOTT. Yes; but he has had no experience except on this canal—no experience in canal construction.

Mr. STEWART. Mr. Menocal has had large experience in canal surveys?

Mr. ENDICOTT. Yes, sir.

Mr. PATTERSON. Have you ever examined the Manchester Canal or the Suez Canal?

Mr. ENDICOTT. No, sir.

Mr. PATTERSON. You have had no practical experience in the construction of canals?

Mr. ENDICOTT. No, sir; I have simply seen the canals in this country.

Mr. DOOLITTLE. Will you state how long Mr. Menocal was engaged in this work in Nicaragua?

Mr. ENDICOTT. He first became connected with it about 1872 or 1873. Mr. Menocal was associated with Commander Lull, and he has been

engaged on these surveys since—I do not know how long in the aggregate.

Mr. DOOLITTLE. Do you regard Mr. Menocal as competent?

Mr. ENDICOTT. I think he is an engineer of ability.

Mr. DOOLITTLE. If you had been engaged in this work during the time he has been, would you feel entirely competent to make a correct statement as to the practicability and the feasibility of this work, and the cost of it?

Mr. ENDICOTT. I think so.

The CHAIRMAN. What other important work of similar character, aside from this canal, has Mr. Menocal ever been engaged upon?

Mr. ENDICOTT. I do not know of any other of similar character. I think he accompanied one of the expeditions which made surveys across the Isthmus of Panama.

Mr. BENNETT. In what year?

Mr. ENDICOTT. It was subsequent to the Lull surveys—about 1875.

Mr. STEWART. Has he not examined the Manchester Canal and canals in India?

Mr. ENDICOTT. I do not think he examined those in India.

Mr. DOOLITTLE. Has he not examined the Manchester Canal, the Keil Canal, and the Corinth Canal?

Mr. ENDICOTT. I think he has examined the Keil and the Manchester canals, but I do not think he has examined the Corinth Canal.

Mr. WANGER. Have you considered the question of a ship railway across the Isthmus of Tehauntepec?

Mr. ENDICOTT. Not seriously.

Mr. WANGER. Have you considered it sufficiently to express an opinion respecting the practicability of it?

Mr. ENDICOTT. I would not like to express an unqualified opinion upon that. I am of the opinion that one can be built, and probably it would only be a question of cost.

The CHAIRMAN. Can it be operated practically?

Mr. ENDICOTT. I think so. I think it is possible to take a ship up bodily and transport it safely, provided you take the necessary precautions.

Mr. WANGER. Of the two propositions, a ship railway and a canal, which do you think is the more practicable?

Mr. ENDICOTT. I think a canal is safer for the transportation of vessels. A vessel is never so easily borne as when water borne.

Mr. BENNETT. That is correct.

Mr. PATTERSON. In making the estimate of $133,000,000, did you take into consideration all the contingencies that occurred to the minds of the Commission at the time?

Mr. ENDICOTT. Yes.

Mr. PATTERSON. Did you make any allowance for unknown contingencies?

Mr. ENDICOTT. We added 20 per cent for that, the same as the canal people did.

Mr. PATTERSON. And you have an apprehension that the cost may exceed $133,000,000?

Mr. ENDICOTT. It may, if the lake can not be maintained at 110.

Mr. PATTERSON. I want to get the state of your mind on that question. Which do you mean—probably or possibly?

Mr. ENDICOTT. I think it is probable. I think it may be impossible to maintain the lake at 110, and if so, there will be deeper excavations in the lake and in the San Juan River. There is very considerable rock there, and that means a large increased cost.

Mr. PATTERSON. What would the possible or probable increased cost amount to? Have you any idea of that?

Mr. ENDICOTT. No, sir; probably twelve or fifteen million dollars.

Mr. PATTERSON. Then, do you think $150,000,000 would cover all possible contingencies?

Mr. ENDICOTT. I think it would cover all engineering contingencies.

Mr. PATTERSON. Would the engineering contingencies include everything?

Mr. ENDICOTT. I am speaking from an engineer's standpoint. I do not consider the interest on the money during the process of construction.

Mr. PATTERSON. You think an outlay of $150,000,000 would give the United States this canal, as you contemplate?

Mr. ENDICOTT. I think so.

Mr. WANGER. In your report you recommend an extension of the Greytown Harbor eastward, do you not?

Mr. ENDICOTT. Yes, sir; to the eastward.

Mr. WANGER. What are the particular advantages of that?

Mr. ENDICOTT. Old surveys and examinations show that Greytown Harbor was originally a bight in the coast line. There was no channel or bar. Originally it was a broad, open roadstead, and the history of it shows that it gradually closed until it made Greytown Harbor a lagoon. A commission of distinguished gentlemen who examined into it under the National Academy of Sciences in 1866 were the first, so far as I know, who found out the true causes of the destruction of the Greytown Harbor. They found the discharge of the San Juan River had little to do with it. The cause of it was drifting sands which filled up the harbor, and they were the persons who suggested jetties to arrest that sand and delay the progress of the destruction of the harbor. They say that it would not restore it, and that the only hope rests upon the possibility of maintaining a navigable outlet, and that dredging must be resorted to or the harbor will be, at no distant day, destroyed.

The shore line is being cut and filled in, and that means the destruction of the bight. It is only a question of time. I believe that the construction of a jetty is the proper method of improving the harbor, but that it should be moved eastward where the end will reach deep water, with very much less length, and where the conditions are now much more nearly stable. A much shorter pier will here reach a point where a line stretching from the end of jetty at right angles to the direction of the wind and the waves will approximate the direction of the east shore line. I think this bight is going to fill up, but that the jetty will arrest it materially. The progress of the filling in of the harbor will be slower, and the harbor will be more nearly permanent and maintained at less cost.

Mr. BENNETT. And it would be of much more benefit to the canal?

Mr. ENDICOTT. The whole expense will be less. It will be economy in the end.

Mr. PATTERSON. In making an estimate of $150,000,000, do you include a good harbor at Greytown?

Mr. ENDICOTT. Yes, sir.

Mr. PATTERSON. All that is in the estimate?

Mr. ENDICOTT. Yes, sir.

Mr. STEWART. I move that the committee take a recess until 2 o'clock.

The motion was agreed to.

AFTERNOON SESSION.

STATEMENT OF MR. M. T. ENDICOTT—Continued.

The CHAIRMAN. Mr. Endicott, we have not a quorum here, but there are seven members of the committee present, probably as many as we will have this afternoon, if you desire to proceed.

Mr. ENDICOTT. Well, Mr. Chairman, I do not know that it is necessary for me to take up the time of the committee any further.

The CHAIRMAN. I will interrupt you to say we occupied all of your time this morning with queries. Now, if you have anything further you wish to state, we will be pleased to hear you.

Mr. ENDICOTT. I have simply a few rough notes of some statements I wanted to make, called out by some testimony presented, but I am informed I can submit that in a written statement and have it entered in the record, and as that will be sufficient, I will not take up the time of the committee. That is entirely satisfactory to me.

The CHAIRMAN. There are one or two matters, I think, I wanted to ask you about. During your remarks to-day you spoke of 20 dams in the river. Explain that matter, if you please.

Mr. ENDICOTT. I think I referred to those on the San Carlos ridge. They are sometimes spoken of as embankments and sometimes as dams. They dam up the water and form a portion of the eastern boundary of these great basins. There are 25 of those instead of 20.

The CHAIRMAN. Will you not explain the general features of this canal, of what the work consists? There is a map before you. For instance, a part of it is simply excavation through alluvial soil. Explain that and point it out on the map, as I would like to get a correct idea of what there is before the constructors.

Mr. ENDICOTT. Well, this is the eastern terminus of the canal at Greytown and the harbor is shown here [illustrating]. This solid red line shows the canal and excavation up to this dam, 9.3 miles.

Mr. PATTERSON. That is all through alluvial land?

Mr. ENDICOTT. Yes.

The CHAIRMAN. Now, is the railroad coterminous with it?

Mr. ENDICOTT. Yes, sir. This black line is the railroad, and from here on, that is what is called the embankment line, the line on which the dams are built to retain the water to the height necessary. From that point on there is a lock, and here is a lock, and here is a lock, and those three locks with the dams are designed to raise the water up to the height of 106 feet above the sea.

The CHAIRMAN. What will be the lift of those three locks?

Mr. ENDICOTT. It will be a total of 106 feet; one will be 40 feet, another will be 35 feet, and another 31 feet. Then in here are the dams adjoining the locks to retain the water in these cuts and basins. At this point will be navigation through what is called the Deseado Basin, formed by means of these dams.

The CHAIRMAN. What will be the height of these dams?

Mr. ENDICOTT. The dams in here are comparatively small and——

The CHAIRMAN. Just about what?

Mr. ENDICOTT. Well, they may be 25 to 35 feet in height, and up here they would probably be 50 feet in height.

The CHAIRMAN. Of what will they be composed?

Mr. ENDICOTT. Of clay. There will be two or three dams of concrete. The present project of the company is to build two or three of concrete.

The CHAIRMAN. What is the total length of those dams.

Mr. ENDICOTT. I do not recollect at this moment. The total length of the banks in this basin would aggregate about 6 miles.

The CHAIRMAN. Can you approximate it in the other basin?

Mr. ENDICOTT. Probably 1 or 2 miles in this stretch.

The CHAIRMAN. What will they rest on—what kind of foundation?

Mr. ENDICOTT. They will rest upon clay. Some of them occur in places where the surface of the soil now is quite soft—mud and marshy—and that will be excavated until they get to good bottom—hard, stiff clay, and they will start the embankments from there.

The CHAIRMAN. Will the material excavated make these dams?

Mr. ENDICOTT. Some portion; yes, sir. But I think most of that excavation will be quite soft and will be perhaps discarded.

The CHAIRMAN. Where will that material be obtained?

Mr. ENDICOTT. There is plenty of it from the cuts and in the hills adjoining here. Then they approach the east divide. This is a cut which is a trifle short of 3 miles in length. That dotted red line shows the navigation through the divide. That navigation is, of course, between rocky banks. The canal here will be 100 feet in width, and about 3 miles long. That carries the canal into what is called the San Francisco Basin, stretching from that point down to the Ochoa Dam, and it is in that stretch where there are a great many large dams—I think they number about 68, with a total length on the crest of about 6 miles. I think the heaviest dam there will be a trifle over 100 feet high—probably 70 feet high from the surface of the ground; but some of them will cross over muddy, marshy places, which will have to be excavated 20 or 30 feet in order to get a good foundation; so, starting from there, the heights will vary up to about 100 feet and over.

Mr. FLETCHER. What will the dam be constructed of?

Mr. ENDICOTT. Clay.

Mr. FLETCHER. And it will be 100 feet high, say?

Mr. ENDICOTT. Yes, sir.

The CHAIRMAN. What will be the width of that on the crest?

Mr. ENDICOTT. That varies according to the height.

The CHAIRMAN. The one you speak of as 100 feet?

Mr. ENDICOTT. What will be the width of that? I think it is about 20 feet, about that.

The CHAIRMAN. What will be the width at the base?

Mr. ENDICOTT. About 600 feet wide at the base.

The CHAIRMAN. Will any portion of that be constructed under water?

Mr. ENDICOTT. They will have to exclude the water. They will have to dam the water back by means of cribs, sheet piling, etc., and then pump out the water.

The CHAIRMAN. Is that contemplated in their plan?

Mr. ENDICOTT. Yes, sir; I think so. I so understand it that their estimates provide for that work.

The CHAIRMAN. Where are the stone dams to be constructed?

Mr. STEWART. Or breakwaters?

Mr. ENDICOTT. A part of the breakwater will be built of stone, but there is no masonry dam in this entire scheme. Some that I spoke of would be built of concrete, and that is sometimes spoken of as masonry.

Mr. STEWART. All breakwaters are contemplated to be built of stone thrown in?

Mr. ENDICOTT. Yes, sir; loose stone thrown in. There will be a great deal of rough stone in the Ochoa Dam, also, according to the plans.

Mr. PATTERSON. What do you think of that plan?

Mr. ENDICOTT. The Ochoa Dam?

Mr. PATTERSON. Yes.

Mr. ENDICOTT. I think it can be built successfully as a rock-fill dam after a proper method and design.

The CHAIRMAN. Will you describe it?

Mr. ENDICOTT. Provided it is not used as a weir, I do not think any water should be allowed to flow over the top of it.

Mr. DOOLITTLE. That is not contemplated now?

Mr. ENDICOTT. I think so.

Mr. DOOLITTLE. Is it not true, according to the modified plans, the water escape is through weirs farther down?

Mr. ENDICOTT. Well, the company, since we commenced to make up our report in New York, have included in the estimates provision for two sluices in the San Carlos embankment, and that will control a small portion of the water during the construction of this dam, and, with the weirs above, a considerable portion after construction, but I understand from their latest report, and Mr. Menocal's testimony which was printed yesterday, that they still adhere to using the Ochoa Dam as a weir.

The CHAIRMAN. Will you describe that dam?

Mr. ENDICOTT. The dam is to span the San Juan about this point (indicating on map), about 1,900 feet in length, including abutments, and it will be about 61 feet high to crest line from mean river bottom. Borings have been made there of the bed of the river to the depth of 20 to 24 feet, and they have not found any rock; it is black volcanic sand. Their proposition is to dam the river with broken stones of large size, thrown in at random, and allow the currents and floods of the river to flow over it and spread out the material on some slope.

Mr. STEWART. What is the difference between a dam and a breakwater?

Mr. ENDICOTT. Well, a dam is built for the purpose of impounding water and to hold it at a higher level, as in a basin; whereas a breakwater is built to protect vessels, or an entrance to a harbor, from waves and the action of the sea, and in this case here (pointing to Greytown Harbor) to also prevent the sand drifting into the mouth of the harbor. That does not dam up the water, or exclude the water on any side, whereas this dam is built to impound and back up the water above that point.

The canal company's proposition is to carry the dam up to the height of 103½ or 104feet above the level of the sea in that manner, and their expectation is it will have a slope of about one in five—that is, for every foot in height it will have a length of 5 feet on the downstream side. On the upstream side they propose to fill in with smaller stone, earth, and clay, and make it as nearly water-tight as possible. It is expected, further, that as this material is thrown into the river the stones will confine the current somewhat, and there will result a scouring between and under these rocks, driving out the sand from underneath and allowing the heavy stones to sink down. Probably they may carry the foundation down as much as 15 or 20 feet by that means below the surface of the river. That, in brief, is what is called a rock-filled dam as distinguished from an earthen dam and a masonry dam.

The CHAIRMAN. It is expected to raise the water from there up to the lake, a height of 110 feet?

Mr. ENDICOTT. Yes, sir; they begin and raise it 106 feet here, and expecting 110 feet at the lake. That dam, together with the San Francisco and San Carlos embankments, impounds this water——

The CHAIRMAN. What is the height of the base of that dam above sea level?

Mr. ENDICOTT. The base of the dam, if that is carried down to the depth of 15 feet, will be about 25 feet above the level of the sea, providing it scours out 15 feet. The present surface of the river bottom there is about 40 feet above the level of the sea. These are mean elevations.

The CHAIRMAN. What is the distance by the river from that point to the sea approximately?

Mr. ENDICOTT. About 50 miles.

The CHAIRMAN. And it has a fall of something over a foot to the mile?

Mr. ENDICOTT. Yes, sir; about that. The dams to which I referred in my testimony this morning were these on the San Carlos ridge. As the water is raised to the height proposed it backs up along the San Carlos ridge for about 12 miles, within which there are depressions which must be closed by embankments.

The CHAIRMAN. What is the San Carlos?

Mr. ENDICOTT. That is the river coming right in here [illustrating]. This map does not show much of it.

The CHAIRMAN. What is the character of these dams?

Mr. ENDICOTT. Well, sir, they are to be of the same general character as those of the San Francisco Basin, built of clay. They are small dams; only a few are of considerable size, probably 40 or 50 feet high.

Mr. STEWART. How are these weirs built, and what are the purposes of the weirs?

Mr. ENDICOTT. Here is where there will be one on top of this ridge for discharging the surplus waters of the basin. It is of concrete or masonry, so as to prevent cutting down or eroding, and destroying the ridge. For instance, if that represented the top of the ridge [illustrating], they would cut down 3 or 4 or more feet and put in concrete sides and base, and paving above and below for a certain distance so that the water rising above this point the surplus would spill over that weir. These are intended, with the weir of the Ochoa Dam and with certain other weirs here, to keep the water down during floods [illustrating]. Then there will be clear navigation from that point [indicating] down to and through the divide and up through the San Francisco Basin to Ochoa, and on to the lake; 64½ miles, they say it is, from Ochoa to the lake, but according to our investigations it is about 69 miles, which adds about 4 miles to the length of the route; that increase is in the river. The total distance has been called 169 and some tenths, but it is 174 miles.

Mr. DOOLITTLE. So the canalization has been properly given?

Mr. ENDICOTT. The canalization cuts, etc., but the discrepancy was in the river navigation. I do not think it will affect the estimates.

The CHAIRMAN. From the Ochoa dam up to the lake the navigation is provided for by the dam?

Mr. ENDICOTT. Yes, sir; well, the river is deepened, and considerable rock and earth will have to be taken out to make it deep enough. Below here [indicating] there is plenty of water; raising the water here gives such a depth in this portion of the San Juan that it is not necessary to dredge any.

The CHAIRMAN. What is the area that will be overflowed by raising the water to that height?

Mr. ENDICOTT. Well, sir, that has never been determined exactly. They simply define the lines here [indicating the embankment lines], and have not attempted to trace out the distance over which it will

overflow. It will be quite extensive, but the land is cheap and costs nothing.

The CHAIRMAN. When you get farther up to those greenish tints, does that represent alluvial soil?

Mr. ENDICOTT. Yes, sir.

The CHAIRMAN. What are the banks of the river there, high or low—the natural banks?

Mr. ENDICOTT. They are rather low.

The CHAIRMAN. Will there be large areas overflowed there?

Mr. ENDICOTT. Yes, sir; there will be considerable overflow there in some places, where it will spread out quite a distance on either side. There has been no instrumental survey to determine how far up that will go.

Mr. PATTERSON. Will it not lift the water up over that light color there around the lake [referring to color of map]?

Mr. ENDICOTT. Not just at that point, because when we get up here the land is high and it will not submerge it, but as we go toward the sea the land falls, and there will be considerable land on each side of the river which will be overflowed farther downstream; but I understand that is no objection, as there is no valuable land there.

The CHAIRMAN. What is the character of the vegetation of those greenish tints?

Mr. ENDICOTT. Well, there is a tropical growth.

The CHAIRMAN. Is it timber?

Mr. ENDICOTT. Yes, sir; and just the ordinary tropical vegetation.

The CHAIRMAN. When you reach the lake, what are the difficulties then of navigation?

Mr. ENDICOTT. Well, sir, at present, here [indicating] the lake is insufficient for the navigation proposed, and it is necessary to dredge out in the lake about a distance of 14 miles.

The CHAIRMAN. What is the present depth of water along that dotted line in the lake?

Mr. PATTERSON. The 14-mile stretch?

Mr. ENDICOTT. When you get out here, the depth is about 30 feet. This is where the cut runs out [indicating]. Beyond that there is plenty plenty of water.

The CHAIRMAN. What is the depth of the water at the outlet of the lake?

Mr. ENDICOTT. It varies with the height of the lake. I think when we were there it was about 11 feet there, and a little less out there—I think 7 feet out there [indicating].

The CHAIRMAN. What is the height of the surface of the sea, 102 feet?

Mr. ENDICOTT. About 101.8 feet when we were there.

The CHAIRMAN. Is there a variation of 8 or 10 feet in the surface of the water of that lake in height above the sea?

Mr. ENDICOTT. Yes, sir; there is a variation there, an extreme variation of high water and extreme low water of about 14 feet.

The CHAIRMAN. What is the extreme height?

Mr. ENDICOTT. I think a little over 110 feet.

Mr. STEWART. Would the building of that canal improve the soil and vegetation by drainage, etc.—the climate and vegetation both?

Mr. ENDICOTT. I think not, up here.

Mr. STEWART. It will below?

Mr. ENDICOTT. It has already improved this country down here. These lands here [indicating] on the east coast are drained and in

better condition than before. Now the sailing distance across the lake is about 56½ miles.

The CHAIRMAN. What is the character of the soil here on the bottom of the lake?

Mr. ENDICOTT. It is exceedingly soft mud, as we found from our own investigations. We went out in a steamer and took soundings for depth, and with poles and rods, in order to test the consistency of the bottom, and found it was very soft.

The CHAIRMAN. What would be the difficulty, if any, in maintaining the depth of water in the channel?

Mr. ENDICOTT. After it is once made, with a good wide slope, I do not think there will be any further trouble. I think the deposit will be very slow, and the expense of dredging it out will be inconsiderable. There is nothing there to create much deposit, and what is there is probably the accumulation of centuries.

The CHAIRMAN. Is there any rock in the way in the lake?

Mr. ENDICOTT. No, sir; not on this side.

The CHAIRMAN. Now, from the other side?

Mr. ENDICOTT. You see the portion in solid red; it is in excavation. About a mile of that first stretch of red is called the western divide. The rise there to it is very gradual and the fall from it very gradual. Then we pass into what is called the Tola Basin. A dam is to be constructed here [indicating] which dams up the waters of the Rio Grande, to fill what is called the Tola Basin. That makes continuous navigation between the lock from this point here over to Lock No. 3 beyond the eastern divide.

The CHAIRMAN. What is the height of that dam?

Mr. ENDICOTT. That is a pretty high dam. It will be about 170 feet in height, probably more, dependent upon how deep they make the foundation. The explorations are not satisfactory, and there have been no indications of rock foundation, and the distance they will have to go to get a foundation will be very great, which makes it a very high dam.

Mr. DOOLITTLE. You mean the height above the surface?

Mr. ENDICOTT. No; I refer to the total height.

Mr. DOOLITTLE. But above the surface what will be the height of the earth?

Mr. ENDICOTT. I think it is 70 feet.

The CHAIRMAN. What will that be composed of?

Mr. ENDICOTT. The proposition was to make that a rock-filled dam also. I believe the company have abandoned that project also, and perhaps they will build one of earth, with a concrete or masonry core or center; but they have not quite decided whether to build that dam or abandon it. They have not abandoned the idea of building the dam yet, but the board believes the danger of such a dam so great that it is not feasible.

Mr. PATTERSON. If they do not build a dam, how will they carry the canal?

Mr. ENDICOTT. Carry the canal in excavation. It takes about 5 miles of excavation.

The CHAIRMAN. After passing from that point toward Brito, what have you there?

Mr. ENDICOTT. Then there are three locks down to the level of the sea. Here is a short line of excavation of 1.6 miles, and here is a lock, and here is a lock, and here is Brito.

Mr. DOOLITTLE. I would like you to state about these locks. The number of locks, according to Mr. Menocal's plans, are three on the

Atlantic end of the canal, and the height of them you stated. Now, there have been statements made relative to a greater number of locks. I would like to have your opinion stated to the committee here as to the feasibility of locks of the height mentioned.

Mr. ENDICOTT. I think it is possible to build locks of the height the company proposes, but it is a very great height. It makes an immense mass of concrete and makes a very heavy weight on the clay foundation, and I do not think there is any necessity for limiting the number to three. I think they will get just as good results by four locks, and it will be more conservative as to weight on the foundations, and the gates will be smaller and more easily handled, and it will not delay navigation.

Mr. DOOLITTLE. You do not regard it as not being feasible to erect locks according to these plans?

Mr. ENDICOTT. No, sir; not as to lifts.

Mr. DOOLITTLE. In reference to material used in these dams—clay material—would you regard that as proper material by your own investigation?

Mr. ENDICOTT. Yes; clay is good material.

Mr. DOOLITTLE. It is a question of putting in sufficient material?

Mr. ENDICOTT. Yes, and laying it properly. There is some danger from clay dams. For instance, if the Ochoa Dam should go out there is always danger of those great dams of the San Francisco sliding away, sloughing away on the sudden fall of water. When the water is high they are charged with water but held, but when the water on the front which presses against them is suddenly lowered they frequently slide down. That is simply one of the dangers of the long system. In case the Ochoa Dam should go out there is this apprehension, and that is one of the several reasons I think the Ochoa Dam should be built almost without regard to expense.

Mr. DOOLITTLE. About what length of time would be consumed in making the rock-filled dam at Ochoa from the rock cut? In other words, the time would cover seasons of high and low water, would it not?

Mr. ENDICOTT. Yes.

Mr. DOOLITTLE. Is not that fact much in favor of the rock-filled dam on that plan of building; that is, building it both at high and low water?

Mr. ENDICOTT. It can be built quickly in that way; yes.

Mr. DOOLITTLE. Does it not insure a better dam if it is constructed during the seasons of flood and low water, knowing the action of the water under those circumstances?

Mr. ENDICOTT. If you could exclude the water entirely, you could construct a dam just exactly as you want it, doing the work very well, consolidating it through the disposition of material to the best advantage for the proper slope, and packing the material in by hand. That can not be done with water flowing over it. The case recited by Mr. Menocal in his testimony, of those dams in India I will say are built in the dry and paved with very heavy blocks of stone on top, and set on edge generally, too; and they intersect the slope with transverse masonry walls at intervals of 30 or 40 feet, and build the slopes at an angle of 1 foot to 20; that is, 1 foot of height to 20 feet of length.

Mr. DOOLITTLE. Is that the case of all dams in India of that character?

Mr. ENDICOTT. Nearly all of them are built in that way.

Mr. DOOLITTLE. Is it not simply a question of putting a sufficient amount of material in there at Ochoa of the rock and the clay and the

silt that is carried by the stream, and that in that manner will be formed a barrier like any barrier of nature against the force of water?

Mr. ENDICOTT. I think so. That is my opinion. Built of proper proportions, and in a proper method.

The CHAIRMAN. Something has been said here about the peril of using canal excavations through rock, the peril of jagged rocks on the edges to iron or steel vessels. Do you regard a canal of that character and of that length as suggesting any impediment in that respect?

Mr. ENDICOTT. No, sir. The width of the cut can be made ample for it and then there is no trouble. If it is exceedingly narrow there is danger of the ship striking the sides and having her own sides injured.

The CHAIRMAN. It will not be necessary to line the canal with timbers and concrete at such points?

Mr. ENDICOTT. For instance, if the width of the cut were 80 feet, as originally proposed by the company, and you wanted to take through it the man-of-war *Iowa*, which has a width of 72 feet 3 inches, it would not be sufficient to take her through, unless the sides of the canal were protected by fenders. It would be extremely difficult; but if it is 120 feet wide there would be no trouble. It is only a matter of making it of sufficient width.

The CHAIRMAN. It is a question of steering the ship?

Mr. ENDICOTT. Yes, sir; of steering the ship. Before leaving the matter of the Ochoa Dam, I mean that it is all right, provided you do not use it as a weir. I do not approve of using it as a weir, as I think that invites disaster.

Mr. WANGER. But if it were a masonry dam it could be used as a weir?

Mr. ENDICOTT. Yes, sir.

Mr. DOOLITTLE. Even then you do not think it will be best to use it as a weir if it has a sound foundation?

Mr. ENDICOTT. If it has a good foundation it is all right. There is danger of an extraordinary high flood coming down and cutting a rock-filled dam down from the top, and when it once starts the whole thing may go.

Mr. DOOLITTLE. If it is put in in high water and low water the danger of that will not be so great?

Mr. ENDICOTT. If it were completed during a flood of one year, for instance when they had to handle, say 60,000 or 70,000 cubic feet of water per second, and the materials had been deposited, arranged, and sloped by a flow of corresponding thickness and velocity, perhaps the next season you might have a flood of 150,000 cubic feet per second, which would rearrange all these materials and cause a settlement or opening which, once started, would wreck the dam.

Mr. DOOLITTLE. I want to ask you about the modern methods in use of taking out rock——

Mr. NOONAN. Have you had experience of dams made of filled rock?

Mr. ENDICOTT. I have never built any.

Mr. NOONAN. Have you seen those where the waters have overflowed the dam?

Mr. ENDICOTT. Of masonry I have, but not of rock fill.

Mr. NOONAN. I want to ask you as an expert, when the water passes over the top of an erection of that sort does it not wash it away and cut it out?

Mr. ENDICOTT. Yes; it is almost certain to destroy it if the water goes over the top.

Mr. NOONAN. So, then, it is a prerequisite in managing a thing of that sort to erect it so high that it shall not overflow?

Mr. ENDICOTT. It is undoubtedly, in a dam of that kind.

Mr. ELLETT. As I understand, there has been a great deal of question here by engineers as to the practicability of building this Ochoa Dam, and I understand you to say in your opinion it is absolutely practical to build a stone-filled dam at Ochoa?

Mr. ENDICOTT. I think it can be built; yes, sir.

Mr. ELLETT. You say it is possible or probable it may wash away?

Mr. ENDICOTT. That is a risk or danger which I think ought not to be taken on a dam of that kind, which affects so great an extent of territory and so many valuable works.

Mr. ELLETT. What I want to know is if you think it possible or probable this stone-filled dam, on account of the character of the foundation, may wash away?

Mr. ENDICOTT. Well, I think it is possible; and if they use it as a weir I should say it is probable. If they do not use it as a weir they can carry it to such proportions that it will stand for all time, probably, if it is built of proper dimensions and slopes.

Mr. DOOLITTLE. I want to ask you about the removal of the material in the rock cut. Do we not with modern methods use channeling machines for cutting down, which leave the surface of the rocks smooth? It is not left jagged, but is left smooth on each side?

Mr. ENDICOTT. Yes, that can be left in good shape. I do not think there is any trouble at all about navigating the rock cut by a ship, providing it is wide enough of course; it ought to be of a good width.

Mr. DOOLITTLE. You were asked this morning whether you would advise Congress to pass legislation that would eventually secure the construction of this work—to carry on this enterprise until a further examination has been made. Now, what would you say in answer to this question? Would you not advise Congress to pass the necessary legislation to insure the completion of this canal, with the understanding, of course, that the engineers of the Government would work out all these details before the construction was taken up?

Mr. ENDICOTT. Yes; I should think that might be done.

Mr. DOOLITTLE. And advantageously, too, would you not think, if the enterprise is desirable as an American enterprise?

Mr. ENDICOTT. Yes; simply to make sure that the investigations have been fully exhausted, and the plan is approved by the Government.

Mr. DOOLITTLE. In other words, do you not believe that sufficient investigation has already been made to demonstrate the practicability and desirability of the Nicaragua Canal to the people of the United States and to the world at large by this time?

Mr. ENDICOTT. Yes; I think so.

Mr. FLETCHER. Let me put that question in another form: Would you, if you had $150,000,000 of your own that you were going to expend, make your engineering investigations before you commenced expending the money, or would you go on and commence the work and make the investigations as you went along?

Mr. ENDICOTT. Well, there is some preliminary work which might be done that would not be affected by subsequent investigation. It would be the part of wisdom, I think, and conservatism, to first make sure of the plans.

Mr. ELLETT. Let me ask you a question. If you were going to expend your own $150,000,000 with the surveys which have been made already, would you deem it necessary, before beginning any work upon

the canal, to go to the expenditure of a large sum in addition for additional surveys?

Mr. ENDICOTT. Yes, sir; I think the interests are so great and so costly it would pay.

Mr. ELLETT. Do I understand you do not value very highly the surveys which have been already made?

Mr. ENDICOTT. Well, I do not say that. I say there are serious omissions and deficiencies which should be supplied. I do not think they are sufficiently exhaustive.

Mr. ELLETT. Is this over the entire route or is it in certain localities only?

Mr. ENDICOTT. Well, more particularly in certain localities. In the lower portion of the route there should be a more careful examination and survey, and up the river, up here, to determine more closely the character of the material and cost. They do not know to-day in what proportions they are going to encounter rock and earth in the upper San Juan; and the matter of the regimen of the lake has not been studied at all, as far as I can ascertain. They have done practically nothing there.

The CHAIRMAN. Do you remember the latitude of Greytown?

Mr. ENDICOTT. No, sir; but I presume Mr. Noble can tell you that, as he keeps those things in his head right along.

The CHAIRMAN. Does the region of the doldrums extend north of that latitude?

Mr. ENDICOTT. I think not, sir.

The CHAIRMAN. Will you look at this map of the doldrums—I suppose you are familiar with it—which comes from the office of the Coast and Geodetic Survey?

[The chairman and Mr. Endicott examine the map.]

The CHAIRMAN. It would be about 12 degrees?

Mr. ENDICOTT. Well, that comes pretty close to it. I will say that they have the trade winds there nearly all the time. Of course, there are times of calm.

STATEMENT OF MR. A. NOBLE.

Mr. NOBLE. Mr. Chairman and gentlemen, I wish to give a classification of the items of increase in the estimate given by the board as compared with the estimate given by the company.

Mr. STEWART. Will you state your profession?

Mr. NOBLE. My profession is that of a civil engineer.

Mr. STEWART. Are you connected with the Government?

Mr. NOBLE. No; I am in civil life.

Mr. PATTERSON. Have you been engaged in this kind of work?

Mr. NOBLE. I was in local charge of the St. Marys Falls Canal about twelve years, from 1870 to 1882, during the improvement of the canal and construction of the lock that is now being used for navigation.

The CHAIRMAN. I suggest that we allow this witness to make his statement first before he is interrupted by questions.

Mr. NOBLE. The total amount of increase was about $63,000,000. Of that, over $4,000,000 was in the way of correcting errors and computations made by the company's engineers. Over $7,000,000 is what may be called new construction—such as enlargement of the railroad system, making a double track instead of a single track, and providing sidings and stations, a provision for quoins for locks, for strengthening foundations by providing sheet piling, etc., when necessary, putting in back

filling behind lock walls (which was entirely omitted in the company's estimate), and caisson abutments for Ochoa Dam, so as to protect the ends of the dam (so that in case of a disaster to the main dam the river could not by any chance cut around the ends), for the temporary diversion of the San Juan River while building the dam, and a few items of that character. Sixteen million dollars to cover increase in quantities from other sources—such as enlargement of channel in the river and the lake, additional harbor work, greater height of dams and embankments, on account of the greater height of water immediately above the Ochoa Dam, to maintain the lake at 110 feet above sea, etc. For increase in unit prices, $29,000,000. Separate provisions for engineering and hospital service, $6,000,000.

In speaking of the company's estimates, we can refer to either of two schedules of unit prices. The first of these schedules is given in all the publications of the company up to this time, and is contained particularly in their estimate of 1890, called the "Report on Final Location." In their estimate of 1895 they made very large reductions in the unit prices, having made a very large increase in quantities, so that the total estimate of cost remains about the same. If the company's unit prices of 1890 were applied to the board's quantities, the total estimate would be nearly $120,000,000. The unit prices adopted by the board have been criticised in the testimony which has been given, and I wish to say to the committee that the board went over the matter with very great care, consulted a large number of contractors, specialists in their line of work, and I would like to read a few unit prices paid on work in the United States and the opinions of contractors as to the proper unit price for use at Nicaragua. Dredging in the Hay Lake Channel between Lake Superior and Lake Huron, in large contracts, has cost in soft material about 15 cents per cubic yard. The dredging at Philadelphia, the largest contract ever let in the United States, cost 14.2 cents per cubic yard.

I visited last fall, while investigating this question, some of the work being done at Greenwich, Conn., where the dredged mud was dumped in a scow and by a patent injector was forced out on some land they wished to fill, and the price of that was 20 cents. We consulted an owner of dredges at Duluth who has been in the dredging business for thirty years, and he advised us to use prices at Nicaragua for harbor work of not less than 25 to 30 cents. A prominent dredging contractor in New York City suggested a price of 20 cents for protected work in Greytown Harbor; he suggested a higher price for dredging in the canal. These prices we practically adopted—20 cents for interior harbor work and 25 cents for the canal work; we adopted 40 cents for dredging in the harbor entrance, on account of its exposure to the sea, taking an average of 25 cents for all. As to submarine rock excavation, which forms a very large item in the estimate, I have been more or less familiar with that class of work for many years, but I consulted in regard to this the one man in the United States who has done the most to devise the methods by which this class of work is being done, explaining to him as fully as I could the conditions at Nicaragua, and he gave the figures of $5 to $6 per yard for work down there.

Mr. DOOLITTLE. Will you state that gentleman's name?

Mr. NOBLE. I will give it to any member of the committee who wishes to verify it, but I prefer not to state it here because the information was given to me confidentially. Will that answer?

Mr. DOOLITTLE. Yes, sir.

Mr. NOBLE. We used the smaller of those two figures. The same

contractor told me that if he was doing that work in the United States on such rock as they would ordinarily find here that he would offer at a much lower figure indeed.

Mr. DOOLITTLE. Did he state what the lower figure would be?

Mr. NOBLE. No; I do not remember that he did directly; but I received the impression it would be somewhere between $2 and $3.

The board's estimate of concrete was made up in great detail, with estimates of the cost of the cement and sand and stone. In order to get the price for cement we applied to the agent of one of the largest dealers in imported Portland cement in the country, and he took the pains to write to his principals in Germany and get the figures for delivery on both the Atlantic and Pacific sides. We used those figures without any increase whatever, and taking the proportions of sand, cement, and stone named by Lieutenant Menocal we arrived at the cost of concrete as $7.90 per cubic yard on the east side, and $7.60 on the west side. Adding 20 per cent for contractor's profit, and the price would be about $9.50 per cubic yard on the east side, and $9 per cubic yard on the west side.

Precisely such concrete as we estimate upon has actually cost about $9 per cubic yard on the Illinois and Hennepin Canal, where it has been done by the Government. The ordinary contract price for such concrete around New York City is about $7, and I think the Government is paying that now at the Brooklyn Navy-Yard. The concrete in the San Mateo Dam, California, which is very largely concrete construction, cost $8 per cubic yard, but the proportion of stone used there is larger than intended in the Nicaragua Canal work, and consequently the concrete was somewhat cheaper. On the other hand, there was a large charge for hauling cement across the country, which would tend to increase the price. So it is probable that that price corresponds fairly well with the price of $7 under ordinary conditions in the United States.

In making up the prices for the western division of the Nicaragua Canal we were guided very largely by an actual proposition made to the Canal Company. It was not a simple proposition to do work at the Canal Company's prices. The dredging at Brito was expressly excluded. He considered a double-track road from the lake to Brito as necessary, and specified certain minimum quantities in the La Flor dam, but in general the company's unit prices for other work at that time—I refer to their 1890 prices—were accepted by him; they were adopted by us, except the price for concrete. The increase in the board's prices in the eastern division I do not think at all excessive when we consider the much more severe conditions, the heavy rainfall, and the unfavorable nature of the ground. All the work in the eastern division, after reaching the locks, is in a hilly country. The canal is through clay hills subject to almost continuous rainfall—a rainfall greater than anywhere else on the Continent, so far as known.

There are a number of points in the testimony given previously that I would like to take up, but I have only had time to make a few notes. I would be glad to put them in better shape.

Mr. WANGER. We will be glad to have you put your comments in writing.

Mr. NOBLE. I will be glad to do it.

Mr. STEWART. Are your views, Professor, in consonance with the views of Mr. Endicott and Mr. Menocal as to the practicability of building this canal?

Mr. NOBLE. There is no doubt it can be built, with the modifications

recommended by the board and spoken of by Mr. Endicott. I am compelled to say if it should be built on the plans proposed by the company there will be a very serious risk in the dams and embankments. Whether the route mapped out by the company is the best route should be determined by further estimates, surveys, and comparisons.

The CHAIRMAN. There is a choice of routes, then?

Mr. NOBLE. Yes, sir; there is. Instead of going across the country from the Ochoa Dam it is possible to carry a line down the valley. The difficulty arises in having to cross these small streams, many of which become quite large in times of flood.

Mr. STEWART. Mr. Menocal takes that into account.

Mr. NOBLE. One of the greatest advantages of the route proposed by the company is the fact that they receive these streams in these basins, which equalize the floods.

Mr. PATTERSON. Are you not inclined to the opinion that the company has selected the best route?

Mr. NOBLE. I can not say that. I have not made up my mind in advance. A further investigation, I think, ought to be made.

Mr. PATTERSON. You think the route selected by the company is practical?

Mr. NOBLE. I think the canal can be built there, sir, but there will always be more or less risk inherent in its maintenance, owing principally to the large number of embankments along the line; a failure of one of them would be disastrous. The smallest stream making its way through one of these embankments would almost certainly cause its destruction, if not discovered quickly and stopped. You understand how the smallest leak will soon grow into a destructive stream.

Mr. DOOLITTLE. By proper material, properly placed, can it not be made perfectly safe?

Mr. NOBLE. A clay dam is never entirely safe. It could not be made entirely safe. There would always be some risk. Here is a long line of embankments, 6 or 7 miles long. It would be almost impossible to have a line of watchmen all along there to guard the canal from evil-disposed persons, perhaps some man who had been discharged and who entertained a grudge against the company, making a hole somewhere in the clay bank and causing disaster. This same thing occurs on the levees of the lower Mississippi River. They are often cut; and if any one is disposed to do it it is difficult to prevent it. Therefore I say there is some risk in this respect.

Mr. DOOLITTLE. But if the embankments are sufficiently large, this is not easy of accomplishment, is it?

Mr. NOBLE. They would be about 20 or 25 feet wide on top and 8 feet above the surface of the pool, so it is evident how little work it would take to cut a channel across.

Mr. DOOLITTLE. But the risk in this case would be no greater than in other work of a similar character?

Mr. NOBLE. The same risk that exists in other similar earthwork construction.

Mr. DOOLITTLE. And there is always more or less of this work on every canal?

Mr. NOBLE. Well, there is not generally so much of it as here. An ordinary canal bank is open to the same contingency, but if cut, the loss would be less. Here there are a large number of embankments, and disaster to one of them would be very serious.

Mr. DOOLITTLE. How much of this amount that you figure as the cost—the hundred-and-odd million dollars—is made up of enlargement of the work that you propose?

Mr. NOBLE. About $16,000,000 are caused by increase in quantities. A large part of this increase is due to the fact that the embankments must be raised, because the water in the summit level would rise 4 feet higher than the company calculates. Perhaps half a million would be due to having flatter slopes for the cut in Lake Nicaragua.

Mr. DOOLITTLE. How is the balance of the difference between yours and the company's estimate made up—the company's estimate which was submitted to you?

Mr. NOBLE. There is an increase of about $7,000,000, mainly in the way of increased railroad facilities and greater harbor facilities.

Mr. DOOLITTLE. This to be added to the sum you just mentioned?

Mr. NOBLE. Yes, sir. The change in the Greytown Harbor includes some other changes and expenditures, such as carrying the breakwater out into deeper water and building a breakwater on the north side as well as the south side. It was found the seas sweeping around the northern end of the main breakwater carried the sands into the harbor, and we understood the company had about concluded it would be necessary to make the improvement just mentioned. We have made some allowance for the probable sinkage into the sea bed or the scour past the rock fill.

Mr. DOOLITTLE. What is the amount?

Mr. NOBLE. The sinkage would be about 6 feet.

Mr. DOOLITTLE. You do not recollect the amount?

Mr. NOBLE. No, sir.

Mr. PATTERSON. How do the ships get up that river now—the San Juan or Colorado?

Mr. NOBLE. The San Juan, ordinarily; when the water is very low they go up the Colorado, and through this little stream, the Rio Bravo [indicating on map].

Mr. PATTERSON. Is that good, navigable water there?

Mr. NOBLE. I think they can count on 5 or 6 feet there. The Colorado carries by far the larger portion of the water.

Mr. PATTERSON. Could it be dredged out and made deep enough for a canal?

Mr. NOBLE. I doubt that very much as regards the lower portion of the river. The bed of the river is sand to an unknown depth.

Mr. PATTERSON. So it could not be utilized as a canal to the sea?

Mr. NOBLE. Not all the way to the sea, I am confident. The country near the sea is very flat and it would be difficult to raise the stream above its level. This is all a swampy country.

Mr. PATTERSON. What other route have you in your mind, Mr. Noble, aside from the company's and the one that runs along the river?

Mr. NOBLE. Three routes have been proposed—one the company's route, and one following the river, and the other following the company's route until you get through the first ridge, and then locking down in this way [indicating route on map] and following the other low level route.

Mr. STEWART. Would you not recommend immediate legislation looking to the building of the canal, with the understanding that more exhaustive surveys should be made?

Mr. NOBLE. I do not feel that I am in a position to offer any advice. So far as my own feeling is concerned, I am very much interested in the Nicaragua Canal, but I could hardly advise this committee what legislation to press through Congress.

The CHAIRMAN. Is there any similar work to that along the basins that you have spoken of, where these large clay dams are? Is there any similar work to that in the world that you know of?

Mr. NOBLE. There are a great many very large earth and clay embankments in the world, and some as high as these.

Mr. STEWART. Are there some higher in India?

Mr. NOBLE. I would not be surprised if there are some there very much higher.

Mr. STEWART. And these higher ones are at places where the rainfall is much greater than it is in Nicaragua?

Mr. NOBLE. I can not say about that. In India the rainfall is apt to be very heavy at times. There they probably have heavier rainfalls in twenty-four hours, but there are not many places in India where they have any more in the year than in Nicaragua.

Mr. DOOLITTLE. Have you stated all the items in which there is an increased estimate of cost, according to their statement?

Mr. NOBLE. I presume not. I have attempted merely to name the principal classes of work. I could go over the estimates in a few minutes, however.

Mr. PATTERSON. Do you subscribe to the statement made by your comrades on the Commission, Mr. Endicott and Mr. ~~Menocal~~, that this canal could be constructed over the line adopted by the canal company, with the additions and improvements that you have agreed upon as necessary, so as to make it an interoceanic canal for all commercial purposes, for $150,000,000?

Mr. NOBLE. I think so, sir. I should feel pretty safe in making that figure.

Mr. PATTERSON. Now, if it is the purpose of the Government of the United States to construct this canal, what objection would there be to passing a bill authorizing the Government to enter upon this enterprise with the view of its construction, and let these additional surveys that you speak of be made under the direction of the Government after it enters seriously upon the work?

Mr. NOBLE. Providing funds were furnished for conducting surveys, and providing the policy of building the canal was entered into, there could be no objection to appropriating the amount necessary to make the surveys, or any larger amount—provided, I say, that the policy itself of building the canal had been fairly entered into and decided upon.

Mr. PATTERSON. That is to say, if Congress has made up its mind to enter upon the policy of constructing the canal, even although the canal should cost the estimate made by the Commission, then there would be no reason why the bill should not be passed and this preliminary work done afterwards?

Mr. NOBLE. I can see no reason, sir.

Mr. PATTERSON. Do you believe that the construction of this canal would result in its becoming such a factor in the international and interoceanic commerce of the world as its friends anticipate?

Mr. NOBLE. I have never examined into the matter of probable traffic, so I can not answer that question.

Mr. PATTERSON. You have never examined into this subject, then, with a view of the importance of the canal as a commercial factor?

Mr. NOBLE. No, sir; I have made no such examination.

Mr. PATTERSON. But have an opinion that an interoceanic canal would greatly contribute to the commerce of the world and the commerce of this country?

Mr. NOBLE. I have no doubt the existence of a canal would develop a large business.

Mr. STEWART. That is not particularly expert knowledge?

Mr. NOBLE. No, sir; I do not say that as an engineer, of course.

Mr. PATTERSON. But you do think that Congress could legislate upon this subject, and do so on the assumption that in no event would the canal cost over $150,000,000?

Mr. NOBLE. I am well satisfied, sir, that the canal can be built across that country at some location, and probably over the proposed route, for that amount.

Mr. PATTERSON. Don't you think it can be built for that over the present location?

Mr. NOBLE. Yes, sir; I say over that location, or some other one, for that amount. I think so.

Mr. PATTERSON. Have you studied the geological history of the country and the history of volcanic eruptions in this part of the country sufficiently to express an opinion as to the probability of the canal being disturbed or injured by volcanic disturbance—by earthquakes?

Mr. NOBLE. I concur entirely in the opinion expressed by the board in their report, that if good reasons exist for building the canal the possible danger that you mention should not stop the work.

The CHAIRMAN. Did you see any evidences of recent seismic disturbance in that part of the country?

Mr. NOBLE. I do not think we found any such evidence, sir. Among the appendices to the report is a letter from Prof. Henry Pittier in regard to volcanoes and earthquakes in Costa Rica and Nicaragua; he is well qualified to treat that matter, being the government engineer of Costa Rica.

Mr. STEWART. Is it a fact that footprints and handwriting in the clay were still visible after four years had elapsed?

Mr. NOBLE. Yes, sir; and marks made by the tools of the workmen.

Mr. PATTERSON. Would not the construction of this canal on the route adopted by the canal company be more advantageous than any other in point of health to operators while they are engaged in the work?

Mr. NOBLE. I do not think there is very much difference between the routes proposed in that respect. A large part of the work would be in the swamps. The climate in the East Divide, where there is much heavy work, would be more healthful, I have no doubt, than in the San Juan bottom.

The CHAIRMAN. Is there labor to be obtained there?

Mr. NOBLE. I don't think it would amount to much.

The CHAIRMAN. From where would it be procured?

Mr. NOBLE. Probably from Jamaica.

Mr. PATTERSON. Would not a good deal of it come from the Southern States?

Mr. NOBLE. I do not know whether laborers from the Southern States could stand the climate.

Mr. STEWART. Plenty of Jamaica labor?

Mr. NOBLE. I think enough for this purpose.

Mr. DOOLITTLE. Is it not true that there was very little sickness among the engineers who were down there a long time?

Mr. NOBLE. Yes; but that is not at all conclusive as to health of workmen on the canal. The engineers in their preliminary surveys have suffered very little with sickness anywhere on the Isthmus, but when the ground is opened there is sometimes more trouble. But I think by using labor from the West Indies there will not be much danger. I think I would rather take my chances in Nicaragua than in the Mississippi River bottom. I would rather be in Nicaragua than at Hopefield. Colonel Patterson remembers that place.

Mr. PATTERSON. Then it must be a pretty healthy country in Nicaragua.

The CHAIRMAN. What is the present value of the works of the company, as you observed them, excluding the surveys?

Mr. NOBLE. I do not know that I would differ at all from the estimates made by Mr. Endicott, except I would not value the plant as highly. I think it is worth very little. Their buildings are of some service. A large part of the railroad line is available; a portion of the line that has been cleared would still come within the limits of a new line. I could not give figures different from his.

The CHAIRMAN. At the breakwater, are the excavations that have been made of value?

Mr. NOBLE. No; I think not. The harbor excavations are pretty nearly filled up, and the canal excavations, I think, would be of no value, because, if the harbor entrance were moved to the point the board thinks proper, the line of the canal would not correspond with the present line at that point.

The CHAIRMAN. How extensive are the excavations of the canal?

Mr. NOBLE. I think they say they have excavated a total of three-quarters of a million yards, perhaps half of that in the canal itself, at a rough estimate.

The CHAIRMAN. Is there any part of the canal complete, so far as the excavation is concerned?

Mr. NOBLE. No, sir. They have excavated to a little over half the full depth, and most of the way only about half the width.

The CHAIRMAN. Was this excavation made with machinery?

Mr. NOBLE. It was made with dredges which they brought from the Panama Canal.

Mr. STEWART. It is a good climate there, isn't it?

Mr. NOBLE. Very moist. The thermometer does not register a high temperature.

Mr. STEWART. Very equable?

Mr. NOBLE. No sudden changes. Occasionally on the east coast the weather is a little severe during northers, but generally speaking it is not extreme. The trade winds blow almost constantly, apparently.

Mr. DOOLITTLE. Will you please state, Mr. Noble, what access you had to the material collected by the company?

Mr. NOBLE. I think they have given us, freely, access to everything they have.

The CHAIRMAN. Did you have any conversation with any person in authority in Nicaragua as to the willingness of the Government of that country for the United States Government to become the principal owner and control this canal?

Mr. NOBLE. No, sir; we did not.

The CHAIRMAN. Did you hear the matter discussed at all?

Mr. NOBLE. I did not. I do not think any of the officials of Nicaragua speak English. I do not speak Spanish. When we called on the President at Managua, the capital, we were accompanied by Mr. Menocal, who was the interpreter, and that matter was not taken up.

The CHAIRMAN. Is there anything further you have to suggest?

Mr. NOBLE. Nothing further, sir.

Mr. PATTERSON. It has been urged before this committee very earnestly by Colonel Andrews—perhaps you know him—that this canal, even if it were constructed, would be so environed by accidents of various kinds—the breaking of dams, injury to locks, and the impracticability of great iron ships passing through it by reason of the jolting against

the rocks that would take place—that the canal would be comparatively useless to commerce. He presents that view of it very forcefully to this committee. Now, what is your opinion in regard to the permanency of the canal and its uses? Is it adapted to the uses that its friends attribute to it?

Mr. NOBLE. I think the canal, with the modifications proposed by the board, would be a useful canal.

Mr. PATTERSON. Be a commercial success?

Mr. NOBLE. Without any doubt, as far as affording safe passage for vessels is concerned. There will always be, as I said before, some inherent risk on account of the long lines of embankments and dams, but aside from that I do not see any difficulty.

Mr. PATTERSON. You have no doubt, then, that the commerce of the world would unhesitatingly adopt the canal for its purposes?

Mr. NOBLE. I do not see any difficulty in passing vessels through the canal. I presume that is the gist of the question. I can not see any difficulty in that, although of course they would have to proceed at a low rate of speed through the rock cuts and other narrow sections.

Mr. CORLISS. How would the sailing vessels be operated?

Mr. NOBLE. Towed through.

On motion of Mr. Stewart, a vote of thanks was extended to Messrs. Endicott and Noble.

REMARKS BY MR. ALFRED NOBLE UPON THE TESTIMONY RELATING TO THE REPORT OF THE NICARAGUA CANAL BOARD.

The Nicaragua Canal Board in its report on the project submitted by the canal company attempted to present the facts it had ascertained in regard to that project. The duty assigned to it proved not an agreeable one, because it was necessary to speak plainly of many omissions of essential data; of incorrect conclusions from observed facts; of misstatements regarding important natural conditions affecting the work, and of large errors in computations of quantities, all tending to reduce the estimate of cost.

The conclusions of the board may be summed up as follows:

First. The data collected are in many respects deficient, either for a final judgment as to the best route for the canal, for an estimate of its cost, or for the information of intending bidders.

Second. The channel widths proposed in the San Juan River and Lake Nicaragua are insufficient for the traffic expected by the company. Besides these large modifications, the project should be changed in many minor respects.

Third. The correction of errors in the company's estimate makes a large increase in the estimated cost.

The conclusions of the board are contested by the company in the testimony of Mr. Warner Miller and Mr. A. G. Menocal, the latter the chief engineer of the company since its organization. For the purpose of reviewing this testimony, in view of the short time available and in the absence of the chairman of the board, Mr. Endicott and myself made a division of the subject. I undertook to treat briefly of the additional surveys and examinations deemed necessary by the board; of the portion of the route between the Ochoa Dam and the Pacific and of the subject of unit prices. Colonel Ludlow in his testimony given recently before the committee has taken up the questions to a greater or less extent and in respect of unit prices very fully, and nothing need be added on this point. The testimony of Mr. Miller as regards

the engineering features of the project is practically covered by that of the chief engineer. In a few cases where he attempts to give figures as to the dimensions proposed for the work, they differ from those submitted to the board and are probably erroneous, as, for instance, the proposed length of the Greytown breakwater (p. 11 of Hearings on House bill 35) and the bottom width of canal (pp. 13 and 16). These remarks will therefore be confined to the testimony offered by the chief engineer.

RAINFALL OBSERVATIONS AND RIVER GAUGINGS.

The position of the chief engineer in regard to this subject is curious. In the first place (p. 68) he recognizes fully the importance of such data and admits that the company's records are deficient; but (second) he claims that such observations must extend over a long period of time and over a large area, and even the results of twenty years' observations "may be entirely upset the twenty-first;" however (third), he proposes during the years employed in construction (elsewhere estimated at six years) to collect the data "to which the works must be adjusted in their completion."

This idea of commencing construction without data and adjusting the works "in their completion" to data accumulated during the construction was adopted at Panama, and all the world knows the disastrous result.

The chief engineer states that "this method is also much simpler than to go through lengthy complicated theoretical calculations based on estimated watersheds, rainfalls, and run-offs." The board made use of calculations based on conservative assumptions for the purpose only of pointing out the serious nature of the problems involved, and to show the absolute necessity of learning the natural conditions before attempting to solve them. It must be remembered that the physical conditions in Nicaragua are different from those to which American engineers are accustomed, and vastly more unfavorable both for construction and for maintenance. That this is the purpose of introducing the calculations, that the method is an unsatisfactory substitute for actual observations of rainfall, measurements of river discharge, and other cognate data is distinctly specified in the report, and the proper data are urgently called for. Still there can be no doubt that the general results of the calculations will be confirmed when the observations are made.

The chief engineer would have it inferred that the period available for the collection of data by the company was only eighteen months, although careful not to state this definitely. As a matter of fact the company carried on work along the line of the canal from 1887 to 1893, a period of about six years, and during that time the required data might have been collected with a good degree of completeness. Starting with this information, and then "making liberal allowance for a possible maximum," as customary in such cases, a fairly complete project might have been presented and a more satisfactory estimate of the cost of the project obtained.

The period of eighteen months named by the board as the shortest period permissible for the collection of new data is admittedly short; but if the work is placed under intelligent control, and conducted with the sole object of ascertaining facts regardless of the conclusions to which they may lead, much can be done and a reasonable project can be presented.

The importance of such data can be illustrated by reference to the

construction hazards of the Ochoa Dam. If a flood of 150,000 cubic feet per second should pass over the dam when built nearly to full height, the velocity of the water down its lower slope would probably exceed 25 feet per second; none of the carefully built anicuts of India are subjected to such a destructive force, although often suffering damage from a much less one. If on the other hand the chief engineer's estimate that the maximum flood of the San Juan does not exceed 63,000 cubic feet per second be correct, the velocity and force of the current down the slope would be much less and possibly not destructive.

The board has good reasons for believing the estimate of 150,000 cubic feet per second not excessive. If observations verify this, the successful building of the dam at the site and by the methods proposed must be considered a matter of chance. If one of these extreme floods should occur during the period of construction it would probably carry away almost the entire rock-fill.

The crude or insecure character of the estimates of flood discharge presented from time to time by the chief engineer is shown by a comparison of his estimates of flood discharge from two basins. One of these is the basin of the San Juan above Ochoa, where the possible flood is minimized; the other is the basin of the San Francisco, a small stream discharging into the San Juan below Ochoa, where the possible discharge is magnified. A large discharge from the San Juan would be unfavorable to the Ochoa Dam during construction, and would require for a proper regulation of the summit level extensive and costly weirs. A large discharge from the San Francisco would be unfavorable for a low-level line following the river, and therefore favorable to the chief engineer's route through the east divide. From the small basin of the San Francisco, with an assumed area of only 65 square miles, he calculates a discharge of 21,000 cubic feet per second. The area draining into the San Juan, excluding the lake basin, is about 2,250 square miles, as scaled on the maps, or thirty-five times as great as that drained by the San Francisco. Over the larger part of this great area the conditions as regards rainfall and run-off are not materially different from those in the smaller basin, yet the floods are assumed to be only three times as great. One estimate or the other is absurd.

The importance of ascertaining the conditions governing the rise and fall of Lake Nicaragua and applying the information to the study of the control of its level after the construction of the canal can hardly be overstated. This matter seems to have received no attention.

It is not intended to treat this subject fully, but merely to again call attention to its importance. The data must be collected, or in other words the requirements must be known before a plan can be formulated intelligently.

BORINGS.

It is a fact shown by the company's records that the borings made in the east divide showed the presence, near the grade of canal bottom and under a great depth of overlying material, of rock reported as decomposed. A sample of it preserved in the company's office in New York confirmed the field notes. If this deposit is extensive, there would probably be a large landslide into the canal, unless the slope was flattened and the pressure relieved; the result would be a large increase of excavation and consequently of cost.

Nearly all the rock samples obtained by the diamond drill have been lost. If they had been preserved and arranged systematically they would have been of great value to the company in order to enable

intending bidders to study the rock and to make the lowest safe proposals for its removal. This would be a sufficient reason for taking new borings if there were no other.

In the upper portion of the San Juan River no borings have been taken, and the proper classification of materials—whether mud, clay, sand, gravel, or rock—is uncertain.

THE SAN JUAN RIVER.

The recommendation of the board that the excavated channel be increased in width from 125 to 250 feet was based in part on experience in the Great Lakes. The width of 300 feet was established for the dredged channel between Lakes Superior and Huron when the tonnage was much less than expected at the Nicaragua Canal, and as the tonnage increased was found insufficient, the principal trouble arising when vessels meet; it was also found necessary to move vessels at a moderate speed, although they were smaller and more manageable than ocean vessels. At the present time these channels are being made wider in many cases to accommodate the larger traffic. As to the depth of water in the channel, it is stated by the chief engineer that it is the intention to make it ultimately 30 feet in all sections, but that in order to reduce first cost certain portions—among them the channel in the San Juan—are to be made only 28 feet deep at first. It would be poor economy in the end to do this. It is obvious at once that in rock sections the process of going over the whole area to remove only 2 feet of material would be expensive, and the same is true to a great extent of the dredgeable sections, and the final cost of the work completed to full depth would be increased considerably.

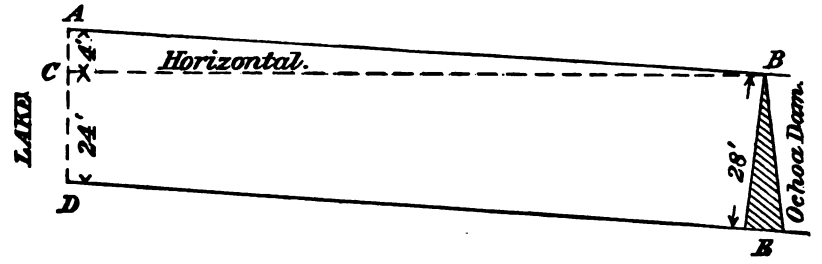
It is believed the company admits for the first time in this testimony the possibility that the level of the lake may run down to 108½ feet above sea level, which would reduce the depth in the dredged channel of the river to 26½ feet, making it at once impracticable for our largest war ships. There can be no reasonable doubt that a still further reduction in depth will occur on account of the draining down of the lake during the dry season.

This brings up the question of slope in the river from the lake to the dam after the completion of the latter. The chief engineer estimates it at three-fourths of an inch per mile, claiming this to be the result of observations on a deep section of the river in its present condition, and says in effect that there are no data at hand on which to base calculations that would be even approximate.

In reply to this it may be said in the first place that where the amount of water is small and the waterway large, as would be the case in the San Juan during the dry season after the completion of the dam, it is practicable to determine from existing data nearly enough for the present purpose what the slope and total fall will be even if there is a large proportion of uncertainty. The ordinary works on hydraulics furnish the method for doing this.

This is not the place to take up the question in detail, as it would be uninteresting to the nonprofessional and commonplace to an engineer.

The importance of the question of slope as bearing on the depth of the dredged channel in the river and lake is very great, as will appear from the following sketch:



A is supposed to represent outlet of Lake Nicaragua; B the Ochoa Dam; A to B the surface of the river according to the company's expectation; D to E is channel bottom. The channel will not require excavation all of the way from D to E, a distance of 69 miles, but only about 28 miles from D toward E. The lake is supposed to be at elevation 110 above mean tide; the river immediately above B is supposed to be at elevation 106, giving a fall of 4 feet in the entire distance.

The board believes that near the end of the dry season the river surface would be practically level upstream from B, and the depth of water in the dredged channel would be reduced from 28 feet to 24 feet, affording passage for boats drawing about 22 feet.

There are two ways to remedy this. One is to deepen the channel in the river, the lake, and through the west divide, or, in other words, to deepen the entire excavation from the Ochoa Dam to the summit lock between the lake and the Pacific; this would be enormously expensive. The other way to secure the desired depth for navigation is to raise the crest of the Ochoa Dam and all the other dams, weirs, and embankments in the vast system by which the summit level is maintained. This would also be very costly, but less so than the other way, and is the method adopted by the board. It results in a large increase in quantities for the dams and embankments and a corresponding addition to the estimate of cost.

With the arrangement of weirs now proposed by the company it is certain that the water level immediately above the Ochoa Dam would be drawn down below elevation 106, and the depth of water in the dredged channel in the river and lake would actually be less than 24 feet.

It was not made clear to the board and is not believed by the writer that the alleged slope of three-fourths of an inch per mile in Aguas Muertas was reliably obtained. As a part of the work of the Lull survey in 1873 a level line was run down the bank of the river, connecting here and there with the river's surface. It is not disputed that the difference of level was correctly given as found; but after passing one end of a stretch and determining the height of water there, several days must have elapsed before reaching the other end and determining the height of water there. During this time the river was probably rising or falling.

The board found no evidence that simultaneous observations of the height of the river were taken at both ends of the line; such observations were the only means by which the actual slope could be determined at any moment. The board therefore attached no value to the reported slope.

For the determination of probable slope in the river at high stages the data are altogether inadequate, and the board found it impossible to arrive at any result of value. Additional surveys and examinations are indispensable for this purpose.

LAKE NICARAGUA.

The reasons for recommending a greater width in the dredged canal at the east end of the lake are stated in the report of the board and in the preceding remarks on the San Juan River. If the views there expressed are correct, the company's project is defective also as regards depth of channel and provides for a minimum channel depth in the lake of 26 feet only, or for the passage of boats drawing 24 feet, by reason of the reduction of level toward the end of the dry season.

The company's estimate provides for side slopes of 3 to 1. These can not be maintained through the ooze which forms the bed of the lake at that locality. The slopes assumed by the board, an average of 10 to 1, are moderate. With these slopes a channel having a bottom width of 150 feet would require about 7,800,000 cubic yards of dredging; the bottom width can be doubled to conform to the views of the board by an increase in excavation of less than 50 per cent.

The need of a survey of the entire lake route for the purpose of navigation is conceded by the chief engineer.

LAKE NICARAGUA TO BRITO HARBOR.

It is believed that a proposition for a low-level basin in the Rio Grande Tola Valley is advanced by the company in the recent testimony for the first time. It was not presented to the board. The survey for an alternate location of a low-level canal through the valley was advised by the board because it disposed of the Rio Grande at the head of the valley and afterwards crossed no streams of importance. The Tola, which is crossed by the company's location, has a channel about 40 feet wide and 15 feet deep where viewed by the board, and is said to run bank full at high floods. Further information is needed as to the magnitude of its floods. The board recommended an examination of the proposed line and a comparison of its advantages with those of the company's line after the ascertainment of the facts; the wisdom of this course will be obvious without discussion to any one familiar with location and construction.

BRITO HARBOR.

After the plan for this harbor had been developed and estimates made, borings with an auger indicated the existence of rock above the grade of canal bottom over a larger part of the harbor area. If the borings were correct they made one of three courses necessary:

First. To remove a large amount of rock under water at great cost.

Second. To move the site farther south and avoid the rock. This was less expensive than the first, and was the basis of the board's estimate.

Third. To reduce the harbor area by excluding the rock area without other change, rendering entrance to the harbor difficult or impracticable. This is the company's remedy.

The earth auger may have given erroneous indications. Instead of rock, there may be bowlders which can be removed by dredging, or the

rock may be soft and dredgeable, and in either case the company's original location can be retained and the cost of the harbor reduced.

In concluding these remarks the writer desires to impress on the committee the fact that the board in preparing its report sought to state with moderation the difficulties of the canal construction and to avoid an excessive estimate of its cost. Where different unit prices were suggested by experienced and reliable contractors, the lowest one was usually taken. During the recent hearings the company has introduced new testimony relating to unit prices. Two of the witnesses are well-known contractors, familiar with work in tropical countries. In both cases their figures when properly analyzed confirm the estimates of the board.

ALFRED NOBLE.

COMMITTEE ON INTERSTATE AND FOREIGN COMMERCE,
Tuesday, April 28, 1896.

The Committee on Interstate and Foreign Commerce this day met, Hon. William P. Hepburn in the chair.

STATEMENT OF COL. WILLIAM LUDLOW, OF THE ENGINEER CORPS, U. S. A.

The CHAIRMAN. Colonel Ludlow, this meeting was devoted to the purpose of hearing anything you might desire to say to the committee in regard to your late service on the Commission in connection with the Nicaragua Canal.

Colonel LUDLOW. Mr. Chairman and gentlemen of the committee, I am not at very great advantage in appearing before the committee, as I have done at their request, because I have been traveling pretty far and fast, and have not had much opportunity to become conversant with the present status of affairs; but I have taken occasion to read, since coming to Washington, some of the statements that have been made before the committee.

Mr. STEWART. Will you state as a preliminary your profession and position?

Colonel LUDLOW. I will do so. I am a lieutenant-colonel in the Corps of Engineers of the Army, and my official relation with the Nicaragua matter began with my appointment as a member of the Nicaragua board in conjunction with two others, Mr. Endicott and Mr. Noble, and my immediate personal relation to the matter terminated on the 1st of November, 1895, when, in accordance with the law, the report of the board was submitted to the President. I would like to say, if you do not object, a few words in regard to the attitude of the board in relation to this question. I have stated that our relation to the project terminated with the rendering of our report. Since then we have all been quite otherwise engaged, and our official connection with it I believed had been terminated. We are glad to furnish any information the committee may desire, and I would like, if you please, to state what our attitude was during the course of our investigation.

It was a subject with which none of us was familiar, but which I believe personally we all regarded with great interest if not with great predilection as an important and interesting work in which everybody was interested. We had little time, or no time, for preliminaries in the investigation of the matter. We were appointed late in April, I think the 25th, if I remember correctly, and we had only a week in New York

to make our preparations. It has been suggested that the purpose of Congress in appointing the Commission was this, that, and the other, for delay, if you choose, or something of the kind. I think the board has the right, and I have the right, as a member of it, to state our position in this respect.

We had no instructions whatever from anyone with regard to the conduct of our investigation, except those which we had from the honorable the Secretary of State, Mr. Gresham, and which are printed in the board's report. We had no other instructions from him, either verbal or written, or from any other person connected with the affair directly or indirectly. We had an interview—I do not think I am committing any impropriety in stating it, it being purely an official matter—we had an interview with the President before we left Washington for New York, purposing later to sail, and we made an official call upon the President before leaving Washington, merely for the purpose of thanking him for the appointment, etc., and we took occasion at that time to express our views as to the nature of our duty.

We recognized the fact that the question had been long before the country and had been the subject of more or less controversy, more or less interesting in Congress and out of it. It was not, as we believed, to be expected that our report would be in any sense satisfactory either to one side or to the other, but we were sent down as the representatives of the United States Government and as professional engineers to investigate and ascertain the exact facts as we should be able to understand them, and to report those facts. We told the President our view of it was that we hoped to be able to submit a report which would approve itself to the engineering fraternity of the world as an intelligent and faithful endeavor to ascertain those facts and report them, and that was all we could undertake to do.

The reply of the President was simply to the effect he was very much pleased to hear what we had said in regard to that, and that the individuals composing the board had been selected and appointed to it for the reason that that was exactly the kind of report that was wanted and it was believed we would make. That terminated our official instructions or anything in the nature of them. We had a week in New York to make preliminary preparations, organize our party, buy our supplies, and arrange for our departure. We blocked out the work for the season, and we in a general way estimated that we had about six months more or less in which to get our work done, and we concluded to divide it equally between work in the field and work in New York in the investigation of the large mass of canal company's data. We spent three months in the Isthmus.

We spent forty days, I think five weeks and over, in Nicaragua. We went over every foot of the route of the canal; we made as thorough and as exhaustive an investigation of the physics and natural conditions as we could in making a journey of that sort. We are the only engineers who have ever been over the entire route, and in making that statement I do not make any exceptions. It remains true to this day. I will, with your permission, refer later to that branch of the subject, and will now go on and simply state, in a general way, that we went from Nicaragua to Costa Rica and investigated the physics of the railroad there, in order to see what was the effect of the climate and rainfall, which had been much dreaded on an outdoor construction of that kind. We were much gratified with what we found. We had exceptional advantages for seeing it, because, after reaching San Jose, the railroad was washed out at a great many places by a heavy rainfall, and

we had to walk back to Port Limon, which, although not being entirely pleasant, gave us ample opportunities to examine it closely.

We went to Colon for similar purposes to investigate the condition of the Panama Canal, so called, since its suspension, to find out what effect the rainfall had been there, and our observations in that respect were also gratifying. We then returned to New York the latter part of July and spent the remainder of the time in, I think, the most laborious, if not exhausting, task I ever had to tackle, and that was to go through the entire accumulated mass of canal data, in order to ascertain what was the information the company had acquired and to perfect such judgment and opinion as we could form, modified and guided by our observations in the country itself.

Mr. STEWART. Would there be any impropriety in the question if I should inquire who wrote the report to the President?

Colonel LUDLOW. The question is unusual, but I suppose there are no reasons for not saying so. I have not any now. We all three wrote it. It was throughout a composite affair. The field was too large for any one man to cover. We were all three interested in the different branches of the subject, and equally responsible for the results, and we all three worked at it as laboriously as we knew how. We worked from 9, or half past 9, in the morning until 5 and 6 o'clock at the office in the army building loaned us for that purpose, and in a majority of cases we got at the matter again after dinner, working until, say, 12 o'clock. Of course this was individually at our homes. We blocked the work out, in a certain sense, and tried to get the field covered, but no one man could cover the whole of it in three months, or six months, or a longer time. However, we managed to get over it, and, while the results were unsatisfactory, we are content, and quite content, in the belief we did our best, certainly, and that what we have done will sooner or later approve itself to those whose judgment is to be respected in this matter when they have had opportunity to investigate the nature of the whole subject. The report is a composite affair. The only man who wrote it all was the typewriter.

Mr. PATTERSON. You all concurred in the opinion that it is practicable to construct the canal?

Colonel LUDLOW. We state that in the report.

Mr. PATTERSON. I refer now to what Mr. Noble and Mr. Endicott stated before the committee.

Colonel LUDLOW. The text of our report on that matter will speak for itself in regard to the construction of the canal—that it is entirely feasible.

Mr. PATTERSON. Within what limitation?

Colonel LUDLOW. Of time or money?

Mr. PATTERSON. Of money.

Colonel LUDLOW. Well, that is difficult to say, because we were not satisfied that we had the information that was necessary to a satisfactory answer to the question as to what it was feasible and practicable to do and what it would really cost to do it. We do not think that information is available to-day, and we so state and urge, and, if you choose, insist upon the procuring of that information so far as it can be done within a moderate and reasonable time.

Mr. PATTERSON. Do you feel entirely certain it can be built within $125,000,000?

Colonel LUDLOW. I do not believe it can.

Mr. PATTERSON. Within $150,000,000?

Colonel LUDLOW. Yes, we think so; as nearly as we can form an

approximate judgment, we think so. I think my colleagues think so. We make a provisional estimate, if you like, of $133,000,000 or $134,000,000.

Mr. PATTERSON. I think that is the amount.

Colonel LUDLOW. It is named in our report and we do state our opinion that the canal, not necessarily according exactly to the company's prices, etc., but that a canal can be built within that estimate, which is a very conservative estimate. I wish we had made it $150,000,000, as I would feel more satisfied in my mind.

Mr. PATTERSON. Do you think the Government of the United States could construct this canal project over the route adopted by the Nicaragua Canal Company, and such a canal as will be entirely safe and sufficient for commercial purposes, within the limitation of $150,000,000?

Colonel LUDLOW. I think an answer to that can not be given until the necessary information can be gained; there are some hydraulic data which must be determined before the engineers——

Mr. PATTERSON. Your investigations have led you to agree that the route adopted by the canal company is a preferable route?

Colonel LUDLOW. Do we express an opinion of that sort?

Mr. PATTERSON. I have referred more to what has occurred here in this room.

Colonel LUDLOW. You see I am quite ignorant in regard to that.

Mr. PATTERSON. What is your opinion on that subject?

Colonel LUDLOW. I think there are better ways of building the canal than to build it according to the project as formulated by the company, as some features of the company's project are absolutely impracticable, and I regard them as impossible.

Mr. PATTERSON. What features do you refer to?

Colonel LUDLOW. Well, the La Flor Dam; I believe that to be practically impossible. I believe, if you choose to speak of minor matters——

Mr. PATTERSON. You refer to the La Flor Dam there [illustrating]?

Colonel LUDLOW. No; it is on the west side here [illustrating]. That is the worst feature of the whole project from an engineering standpoint, and the proposition to construct that La Flor Dam on the lines proposed by the company and as they propose to build it is to my mind impracticable. There is no foundation there for the dam.

Mr. DOOLITTLE. But they have an alternative?

Colonel LUDLOW. Yes, an alternative, and quite a simple and feasible one of a low-level canal, an everyday, plain, common-sense canal which anybody could build, and there would be no serious difficulty in constructing it in that country. There is no question of that, and the advantages of undertaking to build that Tola Basin by means of the La Flor Dam are not sufficient in our judgment to warrant the expense and danger of undertaking to do it. It is a much more dangerous construction, and a more formidable construction in some aspects than the Ochoa Dam, about which we would also, if we were going to make specifications to put it out to contract, like to have further information and study.

Mr. PATTERSON. When you speak of constructing the canal within a limitation of $150,000,000, you mean a canal which will answer for all the purposes of commerce?

Colonel LUDLOW. Not only that. I mean a canal that will answer the United States' purposes as well. I have always been under the impression that the action of the Government in forming a Government commission to investigate the scheme had in view the propriety, necessity if you like, of having a means of communication from sea to sea for our

Navy, and it was with that in our minds beyond any doubt that we went down to investigate the problem.

Mr. STEWART. Do you think the canal will be a source of naval weakness to this Government?

Colonel LUDLOW. That is a rather wide question. I am not a naval expert. If you want to take care of the canal seriously and undertake to control it, it would require some naval force at both ends of it.

Mr. PATTERSON. If I understand you, the estimate which your Commission have placed upon the construction of this canal means a canal that will answer all purposes of the Navy as well as purposes of commerce?

Colonel LUDLOW. The two run side by side. In the case of warships they need a little more accommodation in the way of dimensions than a purely commercial vessel.

Mr. PATTERSON. A canal which would answer the purpose of the Government for naval purposes would answer all purposes of commerce necessarily?

Colonel LUDLOW. Except for the big Atlantic liners, and we have never taken them into consideration.

Mr. PATTERSON. Could not they go through a canal where a battle ship could go through?

Colonel LUDLOW. Well, they are longer than the battle ships, and you have to have the locks longer necessarily to take the liners in.

Mr. BENNETT. It is simply a construction of the locks, then?

Colonel LUDLOW. I think so, and there need not be such a great expense in addition. For example, you need a lock 80 feet wide to get a battle ship through, whereas the company's project is 70 feet, or rather the estimate was for 70 feet, although the project declares for 80.

Mr. PATTERSON. You are an Army engineer?

Colonel LUDLOW. Yes, sir.

Mr. PATTERSON. What have been your opportunities for forming a correct estimate of this kind of work?

Colonel LUDLOW. I do not know. I have been a great deal around on river and harbor work all my life since I have been in the service. I am familiar with harbor construction and matters of river improvement and dredging and contract work of that kind, and have had to do with it ever since I have been in the service pretty much, in the conduct of light-house work and things of that sort.

Mr. PATTERSON. Have you ever constructed a canal or superintended the construction of a canal?

Colonel LUDLOW. No; but canals are in that respect very much like railroads.

Mr. DOOLITTLE. You are reported to have stated that since your last visit abroad you are more than ever convinced of the practicability of the Nicaragua Canal——

Colonel LUDLOW. Of course I did not say that. It would have been gratuitous on my part to have said it and I did not.

Mr. DOOLITTLE. Will you state to the committee what were the results of your observations abroad——

Colonel LUDLOW. I will tell you, if you like, what I did say. These reporters sometimes ask questions not necessarily impertinent, and even an English reporter will occasionally ask you a question to which it is inconvenient to reply, and which might intrude somewhat upon professional propriety. I was asked if I was convinced that the Nicaragua Canal was feasible. I told him I thought a canal at Nicaragua was entirely feasible. That was my answer, and we say so in our report. We think so, and I have no objection to saying it.

Mr. BENNETT. Has your investigation of foreign works led you to feel any more kindly toward the Nicaragua Canal route——

Colonel LUDLOW. I have never felt any other than kindly toward it.

Mr. BENNETT. Any more professionally——

Colonel LUDLOW. It has not affected my view of the physics of the Nicaragua Canal question, because there is nothing in an engineering way that is more strongly individualized than ship canals. They are classified as ship canals—if you like, maritime ship canals—but they are as different as possible in all their peculiar characteristics, although they belong to the same class. You can go and investigate the Suez Canal as much as you like, but you will get very few lessons that would help you in the construction of the Nicaragua Canal from a mere investigation of the physics of the Suez Canal.

Mr. STEWART. Have your late investigations abroad led you to change your report to the President in any respect?

Colonel LUDLOW. Not the least in the world, except, as I gave an answer to a question a little while ago, that I rather wish we had made round numbers in our estimate.

Mr. STEWART. What is your particular expert objection to the route proposed by Mr. Menocal?

Colonel LUDLOW. To the route or the construction?

Mr. STEWART. To the construction and the route.

Colonel LUDLOW. Well, the La Flor Dam is impracticable.

Mr. STEWART. If that were modified, do you consider the Menocal plan feasible?

Colonel LUDLOW. We are not satisfied on that point.

Mr. STEWART. You have no objection to the locks?

Colonel LUDLOW. Except they are not large enough. We think they can be built.

Mr. BENNETT. It is a matter of cost then, is it not?

Colonel LUDLOW. It is a matter of cost, and, in a measure, of engineering practicability. The board tried to be as conservative and conscientious in that as possible. Now, the construction of the Ochoa Dam is a very grave cause for consideration. As proposed, it is absolutely a structure without any precedent in engineering work. It is a vital feature of the canal project, and upon the success or failure of that work depends the integrity of the navigation.

Mr. STEWART. Are not the chances for success at least as many as for failure?

Colonel LUDLOW. We tried to bore into it with all the intelligence and research we could give it and get at the heart of the problem, and I must admit with practically no assistance from the company in our investigation of that subject. They gave us no data and gave us no drawings; they gave us no plan, and they gave us no specifications. We had to go to work and in our minds conceive the necessity for the construction of a dam of that character, and then try how in our minds we could go to work and build it, and you will find we endeavored to set it forth as clearly as we could make it in our report. You will find there that we want more data before coming to a final conclusion.

Mr. STEWART. What portion of the work did you specifically direct your attention to?

Colonel LUDLOW. What work?

Mr. STEWART. Of the observation and investigation of the canal project?

Colonel LUDLOW. We all three went over every foot together.

Mr. STEWART. But there was a portion of the report which you individually wrote, and a certain other portion Mr. Endicott wrote——

Colonel LUDLOW. I do not know that——

Mr. STEWART. You say you worked in cooperation, but that you wrote one part, and Mr. Endicott wrote another, and Mr. Noble wrote another?

Colonel LUDLOW. Separately? Not in the least.

Mr. STEWART. I so understood you.

Colonel LUDLOW. Every branch of the subject in our investigation was gone over by each in turn.

Mr. STEWART. What branch did you specifically investigate? That is what I want to get at.

Colonel LUDLOW. I do not think there is any part of the subject I did not investigate.

Mr. STEWART. As much in one direction as in another?

Colonel LUDLOW. Oh, I was acting as chairman of the board, and my time was taken up with a good many things. I will say this, that there is not a point in the report that every one of us has not gone over carefully, prayerfully if you choose, and investigated. There has been at no time a contrariety of opinion in the board, and the result as formulated is one for which in every part all three of us are collectively and individually responsible.

Mr. STEWART. Well, some person dictated that report to the stenographer?

Colonel LUDLOW. Can you dictate matter of that kind? I can not; it is too important.

Mr. STEWART. Some person wrote the report?

Colonel LUDLOW. Yes; there were three persons who wrote the report.

Mr. STEWART. Three persons could not write the same portion of the report in the same language?

Colonel LUDLOW. Why not?

Mr. STEWART. There must have been someone who wrote a part of the report, and you——

Colonel LUDLOW. And the other two corrected it.

Mr. STEWART. And then the others approved and modified it.

Colonel LUDLOW. All three of us wrote it.

Mr. STEWART. But who wrote it before it was modified or corrected or added to?

Colonel LUDLOW. All three. Will you be kind enough to let me know what this line of investigation is leading up to, as I do not see what it has to do with the current matter?

Mr. STEWART. I will tell you.

Colonel LUDLOW. We have no secrets in the least.

Mr. STEWART. I do not believe you have.

Colonel LUDLOW. I am quite willing to give every member of the committee all possible information they may desire. If your purpose was to ascertain whether this part and that part and the other part individual members of the board are individually responsible for, I can state there is no such part of the report.

Mr. SHERMAN. I see Senator Miller in his statement before us takes issue with what you said just now, that the Ochoa Dam was without precedent. He says there are many such dams in India which are four to six times as long as that, but not as high, and they are built in the same manner, with loose stone filled in with clay material, which makes them tight.

Colonel LUDLOW. No; there is no comparison between the two; you

can not compare the two at all, as the physical conditions and the nature of their construction and the dimensions are totally different.

Mr. SHERMAN. Is he wrong in saying they are the same kind of dams?

Colonel LUDLOW. Oh, quite.

Mr. SHERMAN. Built on the same plan?

Mr. DOOLITTLE. Built on the same foundation or a similar foundation?

Colonel LUDLOW. Sand; oh, yes. They are very interesting constructions, but they are built in the dry, and they are built by hand, and they have elevations of not to exceed 20 feet.

Mr. SHERMAN. Not built in the dry?

Colonel LUDLOW. Yes; built in the dry season. You could not build them by hand in the wet season with 20 feet of water running over them.

Mr. SHERMAN. Are not the rocks just dumped in the river?

Colonel LUDLOW. No; all the face of the work is carefully set by hand, and there is masonry in almost all of them. Nature turns the water off in the dry season, you understand.

Mr. SHERMAN. And there is no water when they build them?

Colonel LUDLOW. No. Then, furthermore, there is a tremendous difference in that many of these greater works are built with foundations. They sink brick or iron wells down in the sand and fill them up with concrete and connect these wells up.

Mr. DOOLITTLE. These are India dams?

Colonel LUDLOW. Yes, sir; they are extraordinarily interesting works. We call attention to all that in our report.

Mr. BENNETT. You questioned the feasibility a moment ago of the Menocal plan for the construction of the Ochoa Dam. The Commission made a suggestion in regard to the construction of that dam, I believe, as to their ideas as to how it should be constructed?

Colonel LUDLOW. We made a serious endeavor to construct it in our minds.

Mr. BENNETT. In your minds you have succeeded, have you not?

Colonel LUDLOW. We were willing to think and hope we had, but before expressing an absolutely definite and final opinion on the subject we declared that we needed more light.

Mr. BENNETT. Exactly. Then your idea of the construction of the Ochoa Dam is that it is feasible, and it is simply a matter of cost?

Colonel LUDLOW. We state our belief that the construction of a dam at Ochoa is feasible. How much it will cost we do not know.

Mr. SHERMAN. I understand you now to say that the construction of the dam on the plan of Mr. Menocal, if it is Mr. Menocal's plan, is not feasible. Do I so understand you?

Colonel LUDLOW. Well, it depends upon what you mean by plan. We regard Mr. Menocal's dimensions as totally inadequate.

Mr. SHERMAN. I mean a dam by dumping rock in the river—constructing a wet dam, you might say?

Colonel LUDLOW. We are inclined to believe that can be done, although it has not been done of any such nature as this. We say so in our report.

Mr. DOOLITTLE. It is a question of putting in sufficient material of proper character?

Colonel LUDLOW. It is largely that, and the arrangement of it, and particularly we regard the abutments connecting the dam with the shore, the point where the angle is formed, and where it is absolutely

necessary the water should not be able to cut around the end of the dam and flank it; we regard that as extremely important, and Mr. Menocal's plan, so far as we know, did not provide for it. The board tried to construct it, you might say, by sinking caissons there, as you will see by the report. We also considered the great danger that that dam would be exposed to from the floods of the river while it was under construction, which is a matter of interest in building that dam. You have a contingency of six or seven years possibly——

Mr. DOOLITTLE. While the canal is being constructed?

Colonel LUDLOW. While the dam is being constructed, and you have all the chances the river is going to give you in that interval, and we do not know what they are.

Mr. DOOLITTLE. Do you not believe a dam that is built during high and low water, covering such a period of time as four, five, or six years—that a dam constructed under such circumstances must stand?

Colonel LUDLOW. We hope in the process of the construction that a dam might be made stable, but it is not clear how it is to be done yet; and we gave very careful consideration to the desirability of taking care of the floods of the San Juan River while that dam was building, and while it was in a comparatively unprotected state, until we could get it above the water to keep the floods from going over it. Now, I will refer to that point, because it is absolutely pertinent. You speak of plans for this dam. The dam is to be used as a weir according to the company's project.

Mr. DOOLITTLE. That has an alternative, too, has it not?

Colonel LUDLOW. No; the company's project is to use that dam as a weir. The alternative is the raising of the dam above the water, and that the board proposes.

Mr. DOOLITTLE. And then use weirs alongside the canal?

Colonel LUDLOW. We use weirs, if you like, and if you choose, several sluices in the San Carlos ridge in the way of regulating things there, because we propose if we were to build that dam to absolutely discard the idea of permitting the river to run over it after it becomes a dam.

Mr. DOOLITTLE. On account of cutting at the crest of the dam?

Colonel LUDLOW. On account of the enormous danger of the floods of the river carrying the dam out and ruining the whole navigation, and allowing the whole canal to wait five or six years while you are building another, to say nothing of the damage below if the dam should fail. And the danger is not imaginary, it is a very real one; you have only to ask any sound engineer on that point and he will tell you that he would not permit water to run over that dam.

Mr. NOONAN. Assuming that is a prerequisite—and I know from experience that is true—that water must not run over that dam——

Colonel LUDLOW. And no engineer would permit it to do so.

Mr. NOONAN (continuing). Is it not then within the scope of engineering science to make it so high and strong as to withstand the water?

Colonel LUDLOW. We have endeavored to do that in our report.

Mr. CORLISS. I would like to ask you, assuming that the Government undertake this enterprise with all the necessary means to push it with dispatch and force as rapidly as it could be accomplished, how long would it take to complete the entire canal ready for use?

Colonel LUDLOW. Oh, who can answer that question?

Mr. CORLISS. I did not know but that you had the skill and knowledge and experience to do so.

Colonel LUDLOW. Well, I would be very glad if I had, but I would have to be wiser than any man living to do that.

Mr. CORLISS. Can not you approximate it?

Colonel LUDLOW. Yes, if you choose to answer in the only way you can answer—with a qualification. The duration of time it might take to fill in at certain places and cut out at certain places, and work at certain places where it is necessary to get dredging done, it will probably take from seven to eight or ten years. The mischances to which you might be subject in that time are not guessable. If you have a dam half built and a flood takes it away, you have to build it again, and in all those works there are contingencies of that kind. The Manchester Canal, in particular, had a bitter experience of that kind.

Mr. CORLISS. How long were they in the construction of that canal?

Colonel LUDLOW. Oh, several years longer than they estimated. Several times they were burst in upon by floods which undid their work, and where they had taken out 10,000 cubic yards the flood brought in 20,000 cubic yards and nearly ruined the contractor, and, in fact, killed him.

Mr. STEWART. With modifications of the report, such as you indicate, would you advise the United States Government to undertake the canal at once?

Mr. DOOLITTLE. Allowing sufficient time for gathering together sufficient data?

Colonel LUDLOW. I hardly consider my individual opinion of the necessity of doing this would be of much advantage to the committee. Individually, I have always been in favor of getting it done.

Mr. STEWART. At once?

Colonel LUDLOW. You can not do it at once, but, if you please, I take this view of it. This is a place, as we state in the report, where it is not well to practice small economies. I will say further, that with the exception possibly of Panama the physical conditions of Nicaragua make it one of the most formidable and dangerous enterprises men have ever undertaken to carry out. You can not modify those physics. You can spend $1,000,000,000, and unless you spend it wisely you will not get through with that canal.

Mr. STEWART. Have you any better route to suggest?

Colonel LUDLOW. Not at all; but I have this to suggest, that before that enterprise be entered upon seriously, and before the credit of the American Government and the American people and American engineers is tied up to it, every precaution should be taken to see that the Panama fiasco is not repeated. I do not mean the Panama robbery, but I mean the inadequate engineering. I am in favor of investigating it thoroughly and then doing it.

Mr. STEWART. Are not the physical and climatic conditions altogether different in Nicaragua from Panama?

Colonel LUDLOW. They are not altogether different. They are both in the tropics, within a few degrees of each other. They have the trade winds more or less, but the rainfall is more dangerous in Nicaragua than has been found on the line of the Panama Canal. There they undertook to cut through a hill without investigating the material properly, and the hill slid in on them and they came to grief.

Mr. DOOLITTLE. In regard to the dangers of the undertaking, are you considering now the question of the length of the work, or do you regard the whole enterprise as having insuperable difficulties?

Colonel LUDLOW. Oh, not at all; it would not be feasible if it were, and we say it is feasible. It is not the length of the route traveled that is so important. The Suez Canal of 100 miles had no engineering difficulties. It was 100 miles of digging a trench through sand without

a lock, the simplest possible canal engineering; it is like building a railroad on the plains.

Mr. PATTERSON. Have you ever looked into the Panama route?

Colonel LUDLOW. Well, we did.

Mr. PATTERSON. Do you think it practicable?

Colonel LUDLOW. I do not know; the French engineers who have been working there say they think it is, and we understood when we were there they expected soon to publish their conclusions to the world and endeavor to secure the approbation and approval of the engineering fraternity as well as capitalists, but we did not examine their data. They did not offer them to us and we did not ask for them. We got considerable information on the subject from a gentleman there.

Mr. PATTERSON. Have you ever given any attention to the proposition of constructing a ship railway?

Colonel LUDLOW. No, I have not. That is another exceedingly interesting matter, but I have never looked into it particularly.

Mr. STEWART. Then your conclusion in regard to this project is that there has not been sufficient study and investigation of the subject?

Colonel LUDLOW. That is at all events the judgment of the board, that a more full investigation should be had than has been given and certain aspects of the canal problem studied, especially the hydraulic side of it, and some other of the topographic side, too, should be determined, in our judgment.

Mr. DOOLITTLE. Do you state you regard this work as feasible?

Colonel LUDLOW. Yes, we regard it as feasible.

Mr. DOOLITTLE. But with modifications?

Colonel LUDLOW. To build a canal there?

Mr. DOOLITTLE. Now, then, you would not regard it as unwise upon the part of this Government, giving to the engineers sufficient time for the collection of detail information, to pass legislation at this time, if you please, which would enable the Government engineers selected to go on and acquire this information, and then when acquired, to go on with the work?

Colonel LUDLOW. Congress starts in with these things sometimes, if that is what you mean. They have in some other cases appropriated liberally in advance, authorizing the use of money for certain purposes, but usually the projects have been very carefully considered.

Mr. DOOLITTLE. Considering the difficulty, I mean of getting the support of the people and Congress for a great undertaking of this kind, if it is deemed at this time it is possible to pass legislation of this kind, you would not deem it unwise to go ahead with such legislation as would secure the collection of this information, and, after the information was collected, the construction of the work?

Colonel LUDLOW. I am sure the consideration of such a matter by Congress would be worth much more than what I could say. There are various branches of the project which Congress would have to consider before tieing the credit of the United States up in this matter.

Mr. DOOLITTLE. I think we have very often much difficulty in getting through necessary legislation——

Colonel LUDLOW (continuing). I think it is absolutely necessary, if you wish and desire the support of the people, to first command their confidence, and present a project which shall approve itself to them, shall speak for itself, if you like. I, however, do not want to commit Congress upon this. I am in favor of doing it, all the same.

Mr. DOOLITTLE. You are in favor of getting the information and constructing the canal?

Colonel LUDLOW. I am in favor of getting the canal through, and have been always, but I want to do it right.

Mr. NOONAN. I understand you can not foresee the exigencies which may arise in the construction of the canal?

Colonel LUDLOW. No.

Mr. NOONAN. And that is the reason why a proper estimate can not be made at this time?

Colonel LUDLOW. Yes, sir.

Mr. NOONAN. Is not that an incident to all great enterprises?

Colonel LUDLOW. Always. That, even after you have made your examination as full and exhaustive as you can make it, you still have to allow for unknown contingencies.

Mr. NOONAN. The science of engineering, like all other human affairs, is progressive, and, of course, we find men who are able to encounter obstacles which arise.

Colonel LUDLOW. That is the way Americans are apt to look at it. We built our Pacific railroads in that way. We have great faith in our ability to get through anything.

Mr. NOONAN. You would at least rely entirely upon the judgment of the engineers who would control the work——

Colonel LUDLOW. Those are engineering questions, sir, entirely.

Mr. CORLISS. What further investigation, in your judgment, should be made by engineers, or your board, before this project should be undertaken by the United States Government?

Colonel LUDLOW. We spent several very carefully written pages of our report in stating that.

Mr. CORLISS. Could you not give us a summary of it?

Colonel LUDLOW. Yes, if you like.

Mr. CORLISS. I will ask you what investigation, in your judgment, should be made that your board has not already made?

Colonel LUDLOW. Well, we need a lot of borings, in the first place.

Mr. CORLISS. How long would it take to complete them?

Colonel LUDLOW. At the rate at which they are made down there I think it took a week or two to make each one.

Mr. CORLISS. How long would it take to do the borings necessary for your board to determine upon the question?

Colonel LUDLOW. In a general way, we estimate we ought to have a year and a half or two years for that investigation. It would take at least that long. I think we ought to have said two years, but we said a year and a half. Of course it is just a matter of judgment, and we estimated how many people it would take, and what it would cost, and how long it would take to do it; and as near as we could get at it, judging from the opinion not only of ourselves but of men familiar with the country, we consider it would take from a year and a half to two years.

Mr. DOOLITTLE. The cost of the canal, in accordance with the report of your Commission, is largely increased over that of the company. Now, is not that largely owing to the enlargement of the proposed canal by the board and large increase in the removal of material?

Colonel LUDLOW. That is part of it, and a part of it is increase in the unit prices, and part increase in quantities, and part is correction of errors of the company's computations—some millions; I think $6,000,000 or $7,000,000.

Mr. DOOLITTLE. Is not this canal, in accordance with the project of the company, as large as any other canal in the world in width?

Colonel LUDLOW. I think, take it by and large, that this is more formidable.

Mr. DOOLITTLE. I mean in width and dimensions.

Colonel LUDLOW. No, the canal is not laid out on dimensions as large as other canals.

Mr. DOOLITTLE. What other canals exceed it in dimensions?

Colonel LUDLOW. The Suez is one with which comparison is naturally made, being the only one similar in character, you might say, to this Nicaragua Canal.

Mr. DOOLITTLE. But these plans contemplate a larger plan than the Suez when it was completed?

Colonel LUDLOW. Yes, quite true; but the Suez people found it necessary to increase it.

Mr. STEWART. Do you regard Mr. Menocal as a competent engineer?

Colonel LUDLOW. I do not think the committee really would want me to answer that question, as it is quite personal.

Mr. STEWART. I withdraw the question.

Colonel LUDLOW. I would rather you would not ask that; but I would have no objection to answering it.

Mr. STEWART. If your board had spent the time spent by Menocal at Nicaragua, would not you then feel competent to express an opinion as to the feasibility and practicability and possibility of the route?

Colonel LUDLOW. If we had spent seven or eight years, surely. But mere duration in the country has not anything to do with it; otherwise you could get better information from a native than anybody else.

Mr. STEWART. But I am supposing you were actually engaged in the prosecution of this enterprise.

Colonel LUDLOW. Oh, surely; and it ought not to take as long as that to get it. We do not hesitate to say that in our report. We had sympathy and consideration for Mr. Menocal and everyone else connected with the matter. We had no antagonism to anybody, and we have had no friction with the company. Our relations have been entirely pleasant.

Mr. STEWART. The reason I asked the question was that Mr. Noble and Mr. Endicott expressed a very favorable consideration for Mr. Menocal's professional ability.

Colonel LUDLOW. I like him very much, but as to his professional ability I have no other means of judging except by his work, and it is unfair to have to condemn a man as an engineer because he has not been able to do all the engineering he would like to do. I do object, however, to the statement he made that the engineering has been sufficiently done. I totally disagree from that, and we found it inexplicable that in all the time the company has spent on that project—it might be, perhaps, because it would cost a little more—that they have not the information which the board required, and which I apprehend every engineer will require and will regard as absolutely indispensable.

Mr. BENNETT. You said when you had completed your course over the route you were the only engineers who had ever covered the entire line of the canal?

Colonel LUDLOW. Yes, sir; I would like to postpone the answer to that, because I would like, with the permission of the committee, to say something on that later. It is, however, quite true, as we believe.

There are some aspects of this matter which are very peculiar. I have not had much time to go over this more recent literature, but I am reasonably familiar with the former publications on the canal, and I do not think I have ever been more surprised in my life than in reading this pamphlet containing the Miller-Menocal testimony, of which I have a copy and which I spent last evening in examining and making notes. I have had the pleasure of meeting Mr. Miller, who is a very amiable

and accomplished gentleman. I have always liked him and have been indebted to him for courtesies, and I do not believe he intends to impute anything really disagreeable to the members of the board or say anything disagreeable about them.

I do not believe he intends to do that any more than I would attempt to do it about him. He says things here which have no verity, but it is quite easy to see he has derived his judgment from the opinion and statements of others, and not from his own knowledge. I do not suppose he would expect a very strict examination of the engineering which he has stated there and makes points about. Of course, you understand Mr. Miller is not an engineer, though doubtless learned in other directions. But there are a good many things which need to be covered in this inquiry, and mere personal matters I would like to defer, because there is an aspect of that which is somewhat serious, and, with the permission of the committee, I would rather go over the technical matters first. I have taken occasion to make some notes, and I have certain data which at the outset I will endeavor to lay before you. The board found, on examining the canal literature, very numerous and more or less definite statements with regard to the investigation of this project by American and foreign engineers—English engineers—sometimes individual engineers and sometimes a board of engineers.

We found many references to that matter, and naturally we were desirous of knowing what English and other engineers had investigated the subject. We had before us the publications of the company and reports of the board—a consultation board in New York, which represents an American board, called from the name of the chairman the Bogart board. We had that before us. Then it was determined to find out who these English people were. The board could not get definite information on the subject either by inquiry or correspondence. The board wrote finally to Mr. Menocal and asked him who they were, and he stated in effect he was not at liberty to state what the reports were, as they had been confidential, and while he had been informed they were of a favorable character he was not prepared to furnish them. Later on the thing became more definite.

Presently there was a publication by Captain Merry, associated with the canal, and who is very much interested and enthusiastic about it, to the effect that there was an estimate made by a board of English engineers corroborating Mr. Menocal's estimate to within $600,000. And Mr. Miller, unless there is a misprint in this, has stated to the committee that the report of an English engineer corroborated Mr. Menocal within a million dollars. Well, we found the name of the engineer to be Mr. Donaldson, a gentleman formerly connected with the Manchester Ship Canal and now connected with the London and East India Docks—a man of repute and consideration. I was very much pleased at having an opportunity of meeting Mr. Donaldson in London. I talked to him about this since his name was mentioned, and he was surprised at the aspect of the case and the way his name had been used. I will, with the permission of the committee, read briefly what the record is on the subject. We wrote first an official letter to Mr. Menocal, which is as follows:

NICARAGUA CANAL COMPANY, ARMY BUILDING,
New York, October 1, 1895.

DEAR SIR: The board is recently in receipt of copies of a pamphlet on the Nicaragua Canal by William L. Merry, purporting to be published by authority of the Chamber of Commerce of San Francisco and other responsible bodies.

The description of the canal is evidently obtained from the company's records, and on page 26 the following statement appears:

"The cost of the canal has been very carefully estimated by Engineer Menocal

and by two boards of consulting engineers, one in the United States and one in England. Menocal makes a cost of $65,084,176, exclusive of bankers' commissions, discounts on securities, and interest during construction. The English board exceeds this by $600,000, a remarkable concurrence."

Will you be kind enough to give the board such information as you may have relative to the composition or personnel of the English board of engineers, to whose report reference was made, the nature of its investigation of the canal project, when it was made, and what were the unit prices upon which the board's estimate of $600,000, more or less, of excess of the company's estimate was based?

Very truly, yours,

WILLIAM LUDLOW, *Chairman.*

Mr. A. G. MENOCAL,
Chief Engineer, etc., Brooklyn Navy-Yard.

Colonel LUDLOW. Now, if you please, I will read Mr. Menocal's reply, and then I will read one more letter, and that will close that part of it:

UNITED STATES NAVY-YARD,
New York, October 2, 1895.

DEAR SIR: Referring to your letter of the 1st instant, regarding the statement contained in a pamphlet on the Nicaragua Canal published by William L. Merry, in which he states that the estimated cost of the canal as computed by a board of English engineers exceeds the estimates made by me by $600,000, I can only say, in reply to your inquiries, that in my opinion Mr. Merry refers to the report made by Mr. H. F. Donaldson, chief engineer of the London and East India Dock Company, to the syndicate that employed him to visit Nicaragua and examine the route of the canal, the proposed plans, estimates, etc., and to report his conclusions thereon.

Mr. Donaldson was at the time engineer in charge of a section of the Manchester Ship Canal.

He visited Nicaragua with another engineer of the Manchester Canal Company, Mr. Gooch, associated with him in the investigation in 1891, and inspected the route of the canal, the plans, the work then in progress, etc., spending about one month in the country. They then went to Costa Rica and examined the location of a railroad in that country, in the interest of the same syndicate, after which they came to the United States, visited the Sault Ste. Marie Canal, and spent considerable time in the Nicaragua Canal Company's office in New York, examining the plans, records, etc., of the company.

I am at liberty to say, regarding his report, beyond his unreserved statement to me and, I think, to others in London, to the effect that he had fully indorsed the project as proposed in the company's plans, and that his estimate of cost was very close to the one made by me. Whether the difference was $600,000 or £600,000, I am not prepared to state. His report is private property of the syndicate that employed him, and, as far as I know, has not been published.

Very truly, yours,

A. G. MENOCAL.

Col. WILLIAM LUDLOW, U. S. Engineers,
Chairman Nicaragua Canal Company.

Colonel LUDLOW. I took occasion, in meeting Mr. Donaldson in London, to inform him that he had been rather prominently and authoritatively quoted as indorsing this project, and asked him if he would let me know what his views were on the subject, as it was a matter of great interest, and I found him in the first place surprised at the use that had been made of his name, and, in the second place, entirely dissatisfied to occupy the position in which these various communications put him, and he asked me if I could suggest to him any way by which he could rectify the matter so far as he was concerned. I stated to him that he might write me a letter on the subject if he chose, and I would use it, officially or otherwise, in any way he desired, and he thought that was a good plan. I will now read you his letter:

109 LEADENHALL STREET, LONDON, E. C., *April 14, 1896.*

DEAR COLONEL LUDLOW: Referring to our conversation the other evening, I think it only just to myself to draw your attention officially to a point which seems to require some remarks from me. I understand that it has been officially intimated to you that some of the references in the Maritime Canal Company's various publications to the reports, etc., of English engineers refer to the visit I paid to Nicaragua and the confidential report which I made to my principals on my return. Were

it not that estimates are specially dwelt upon in the publications I have referred to, and that I understand that you have received an official intimation to the above effect, I should not deem it worth while to write to you on the subject, but seeing that I am represented as having made estimates with a view to total cost I would ask you to understand and to represent my views of the case (which are as follows) to your Government.

As a portion of my confidential report it was part of my duty to collect information as to the probable units of cost of work in Nicaragua, and to carry this into effect I adopted, avowedly without any checking, the figures shown, as the quantities of work to be done, in the canal report of 1890. For the purpose of my report it was not necessary to check these quantities or discuss any point which I considered, and still consider, necessary for the proper completion of the canal. These matters which I have mentioned may in some cases tend to decrease cost, but, without doubt, the net result would be a large increase upon the total for a lump-sum estimate. My report being confidential, I am unable to give you the total figure I arrived at, but even if I gave it you I do not think it would be of any service, seeing that in many cases I drew special attention to the fact that the information was insufficient, and that, therefore, I could do nothing but take the units of cost—notably for the lock gates—which were shown in the report of 1890 I have referred to, and, moreover, the total which I arrived at would be by no means reliable in arriving at the total cost of the canal, as I only included net costs and allowed practically nothing for contingencies. Under these circumstances it appears to me very misleading to suggest that any estimating which I did can safely be taken as a basis of my opinion as to what the total cost of the canal will amount to, both on account of the indefiniteness already referred to with regard to the locks, and also to many other points which appear to me to require revision.

Yours, faithfully,

H. F. DONALDSON.

Col. WM. LUDLOW,
Embassy of the United States, London.

Colonel LUDLOW. You will observe what a different aspect the matter immediately presents by that letter submitted to the committee as a part of the record at the request of Mr. Donaldson. He went down there to make unit prices. He had no means of checking quantities, measuring, or leveling. The people who sent him there wanted to know what the work would cost per cubic yard, or mile, or foot. He looked over the project, that of 1890, and there were a great many things which he regarded as of serious moment, but in making up his unit prices he took no account of these, and in making his estimates put no allowance for contingencies in it. I know otherwise what his total is, but I am not at liberty to state it. It would not be satisfactory to those who believe that it is an indorsement of the company's project within a $1,000,000, or $600,000, or £600,000.

Mr. DOOLITTLE. I suppose it would show what was in his mind at the time?

Mr. WANGER. As to the unit prices.

Mr. DOOLITTLE. And all the other matters embraced in it.

Colonel LUDLOW. I only present the matter in pursuance to Mr Donaldson's request, and I have discharged my duty in doing it.

Mr. PATTERSON. His report is not a part of the record?

Colonel LUDLOW. His report is not a part of anybody's record, because it was made to his employers, and as far as I am aware it is confined there.

Mr. DOOLITTEE. Of course, it may be easily made a part of the record before the committee?

Mr. PATTERSON. I understand it is a confidential report.

Colonel LUDLOW. If you do, you will have to get it, as I could not.

Mr. DOOLITTLE. If the company saw fit to submit it we could get it.

Mr. PATTERSON. As I understand it, he made no report to the canal company, but made the report to his employers in England.

Colonel LUDLOW. To Mr. Walker, the great English contractor on the

Manchester Canal, who I learned had a large amount of canal plant for sale.

Mr. JOY. Did you get his estimate?

Colonel LUDLOW. I have it confidentially.

Mr. JOY. Directly from Mr. Donaldson himself?

Colonel LUDLOW. No; I can not say that. I say I got it indirectly. He did not consider himself at liberty to communicate it, and that is the reason he stated what he did, and for the additional reason that it would be of no value, which is a fact, because it is a mere taking of the unit prices which represented the exercise of his judgment in the matter, and a taking of the company's quantities which he did not seek to check and had no means of checking, so he worked up the company's quantities and his own unit prices and arrived at a column of figures. Now, you can add those up. There are serious additions which Mr. Donaldson regarded as necessary to the project in order to make it satisfactory as an engineering project, and there is no item for contingencies in it, as he only put in a few thousand dollars in order to make up a round sum.

Mr. JOY. Then you are familiar substantially with the details of the report made to his principal?

Colonel LUDLOW. Not in the least. I have not seen a word of it, and do not know of it except what Mr. Donaldson chose to communicate to me.

Mr. JOY. I understand you had some information outside of the letter you have read?

Colonel LUDLOW. I have had some information.

Mr. JOY. Going beyond the substance of the letter?

Colonel LUDLOW. I have the communication of Captain Merry.

Mr. JOY. I mean in reference to Mr. Donaldson's report?

Colonel LUDLOW. Only what I got from a friend of his who was not aware at the moment that Mr. Donaldson had said anything on the subject, and he had not at that time in fact. The only thing I rest on in the matter is of course Mr. Donaldson's statement which he desired to me to submit to the committee here, or to my Government, as he called it.

Mr. JOY. You have the statement because you have gone considerably beyond the contents of the letter itself, and that is the reason I asked if you had seen the full report?

Colonel LUDLOW. No, sir; personally I have no further information.

Mr. STEWART. Mr. Donaldson is an enthusiast in regard to the Nicaragua Canal?

Colonel LUDLOW. Oh, no; he is not an enthusiast about anything.

Mr. STEWART. But he is strongly in favor of it?

Colonel LUDLOW. He did not say so. All I talked about with Mr. Donaldson was the question of his name being used as indorsing the project and estimate, and I did not ask him what he thought about the enterprise.

Mr. JOY. You devoted a considerable portion of your time while abroad in looking into other canals and estimating in view of this report?

Colonel LUDLOW. I got a large amount of data, and I was traveling and working all the time almost, and accumulated a large amount of material; but I have not been able to sit down long enough to look it over sufficiently——

Mr. JOY. Was that visit for the purpose of making this investigation into other canals?

Colonel LUDLOW. I had instructions from the War Department.

Mr. JOY. And it was not for pleasure?

Colonel LUDLOW. It was a pleasure in one sense, but it was very hard work in another. I had orders from the Department to go.

Mr. STEWART. Did you start the inquiry in Nicaragua with any preconceived opinion of the project, either in regard to the feasibility or nonfeasibility of the Menocal route?

Colonel LUDLOW. I thought it was all straight.

Mr. STEWART. You had a preconceived opinion?

Colonel LUDLOW. Yes; if you like, in favor of it.

Mr. STEWART. And in favor of the Menocal route?

Colonel LUDLOW. As I understand it, the company's route. I did not look into the matter as to who was individually responsible for it. I did not know, necessarily, it was Mr. Menocal's route.

Mr. STEWART. Then your investigation removed that preconceived opinion; your further investigation and study of Nicaragua removed that preconceived opinion?

Colonel LUDLOW. My opinion, if you like, and the turn of my mind and my view of it were entirely favorable. I had read the reports of the company, in which it was stated that the investigation was complete and full in every particular, that there was no problem left unsolved, that every survey had been made, that borings had been made the whole length of the canal, and so on, and so on; and I could not but believe, of course, that the investigation had been made as thorough as it was represented to be. We found it was not.

Mr. STEWART. During your investigation did any hostility in any way arise?

Colonel LUDLOW. Not in the least. Our relations were very pleasant, and there were only one or two points of friction, because Mr. Menocal had one view about things and we had another. He thought it would be better, for example, to pursue a certain course, and arranged for taking it up in a certain way; and after we looked into the matter ourselves we found, from our point of view, in our judgment, it would be better to change this arrangement, and there was a little friction about that.

Mr. DOOLITTLE. This occurred about the investigation?

Colonel LUDLOW. Yes.

Mr. DOOLITTLE. And you came back more favorably impressed with the general feasibility of the canal than you carried with you when you went down there?

Colonel LUDLOW. I am sorry to say I had grave doubts.

Mr. DOOLITTLE. Of the whole project—about the feasibility of it?

Colonel LUDLOW. About the whole project.

Mr. DOOLITTLE. Were they doubts about the whole project?

Colonel LUDLOW. I had great doubts about the feasibility.

Mr. DOOLITTLE. Of the entire project?

Colonel LUDLOW. Yes.

Mr. NOONAN. I would like you to state the character of them.

Colonel LUDLOW. Why, there was the fact that data which we regarded as indispensable had not been obtained. We asked about this, that, and the other. We asked what were the floods in the San Juan River, etc., and we could not find out.

Mr. BARTLETT. Mr. Chairman, it is now 12 o'clock, and I move that we adjourn until 2 o'clock and the hearing be continued then.

Thereupon the committee adjourned to meet at 2 p. m.

AFTERNOON SESSION.

STATEMENT OF COL. WILLIAM LUDLOW—Continued.

I desire to refer to some remarks which I made in answer to Mr. Doolittle, and about which there may be some misapprehension as to what I meant. He asked me as to my disposition toward the project before going there, and I stated that it was entirely favorable; and then he asked me as to my disposition when I returned, and I stated that it was discouraging. Later, of course, we had an investigation in New York about the canal, when we went over the company's data. We derived from that a little more favorable opinion than we had when we first came back, and I will state why. We commissioners were living and almost sleeping together, and our conference was continual. I speak of my own impressions, because I can only do that. So far as the company's project was concerned, I could not see any way by which the Ochoa Dam could be built in the way in which the company proposed to build it. Failing this, if a site for a masonry dam could not be found, it did not seem practicable to build a high-level canal at all. Then the alternative would be to abandon that and build a low-level canal along the river, as had been proposed by Childs and Lull.

Mr. Menocal's views upon this question were extremely positive that it would be found impracticable. What I had in mind to say was that I could not see how, with the Ochoa Dam as projected, we could build a high-level canal, and if Mr. Menocal's views as to a low-level canal were correct and there was no other alternative, the canal was not feasible, but we found means later to reach a better judgment after a fuller examination of the whole subject; and the result is summed up in the statement made in the report, from which we have no reason to depart, that the construction of a canal on the Nicaraguan route is entirely feasible. I do not think there is a doubt but what it can be done. How it can best be done and what it will cost remain yet to be determined.

I say this because in conference with my colleague and in talking about the matter we thought there might be a misapprehension as to what I intended to say. I do not wish to have anyone believe that there is any doubt in the minds of the board, as engineers, that the construction of a canal is feasible. I think it is certainly feasible.

I have referred, Mr. Chairman, to the matter of the references made and authorities quoted as "the English engineers." I would like also briefly to refer to the matter of the board of American engineers who have considered this subject. We have a copy of that report, which has been published a long while. It was made May 9, 1889, by a number of engineers who sat in New York and examined the canal data submitted to them, and who considered the subject as carefully as they could from that standpoint alone, without a personal investigation of the Isthmus or a visit to the Isthmus, but from an examination of the company's data as they were prepared for them. The total estimate made by that board was one-third, or 35 per cent, greater than the company's estimate. In our report we did not refer to that report, although we have forwarded it as an appendix for information. We did not discuss it in our report, because, among other reasons, we did not believe that the Bogart board had been fairly treated.

We were struck with certain things which seemed to indicate that there had been some misunderstanding, and to which I will call attention at another point. The Bogart board states that it has gone over in

the usual way the maps, using the company's data and, largely, the company's quantities, although they make a considerable difference in the estimate of the work. At the bottom of page 2 the board states, "These locks are shown by the borings submitted to be all *founded on rock.*"

The next publication that appears on the subject is the Report on Financial Location, which followed 6 months later; at least it appears under date of January 31, 1890. If you will look in that report, you will find that it is nowhere stated that any of the locks are founded on rock, as in fact they are not. If I am not very much in error, the best material to which the foundation of locks is attributed in Mr. Menocal's report of 1890 is "solid ground." Evidently the information given to the Bogart board was seriously incorrect in that particular, if you please. That board was led to believe by the borings submitted to them for their examination and for the exercise of their judgment that these huge locks, such as the world never saw, and perhaps never will see, tremendous constructions, were to be founded in the "solid rock;" and the chief engineer's report, which followed soon after, makes no reference to that "rock," but does to "solid ground."

We thought the Bogart board should not be held responsible for their statement, but they increase the company's figures one-third, and yet the company's report makes no use of those figures. Mr. Menocal's estimate in 1890 is the same as it was before, without paying any attention to the recommendations of this board of engineers, and it did not seem to me that it was altogether a fair way to treat the board, and our board did not undertake to discuss it, for that reason, among others.

There may be some misapprehension about this, because the totals of this Bogart board have been referred to as being used by the company, and it is true in a sense, perhaps, but not in a correct sense. The Bogart board made a construction account, not an interest account, and took no account of financial expenses. It is an engineer's or a contractor's estimate, with allowances for contingencies. There are no extraneous charges in it. The company has used the Bogart board total, but made it cover financial and incidental expenses also.

Mr. WANGER. I would suggest that instead of using the word "this," you designate it more clearly, so that the stenographer's notes may show it.

Colonel LUDLOW. That is quite correct. The company's estimate is of the same nature, but they are engineers' and constructors' accounts. It is true the company used the figures which were before included within the additional expenses, and have gradually arrived at a probable total to include financial arrangements of perhaps one hundred millions. But it put the Bogart board at a disadvantage. I trust your committee will not have any unnecessary misapprehension on that point. I would like to go through this matter as fully as I may, because I wish to have you understand it before we get through. I have been going over the testimony here with much haste and some amusement, and a good deal of surprise. In the testimony which has been given by Mr. Menocal and Mr. Miller—I will not criticise Mr. Miller, because I do not think he meant to be disagreeable in reference to the board, but he does make some semifacetious reference to it. I presume he intended it as such, but there is no intention to hold Mr. Miller responsible for any engineering data, because he is not personally acquainted with it, and can not be; but he used the information very properly which he got from the engineer and staff of the company.

It struck me as singular in looking at this that the difficulty

encountered at the outset in the investigation of this project was a certain fluidity or elusiveness about it. We could not get statements made at different times and in different publications that would cohere. We found that difficulty with reference to the Ochoa Dam. In the new estimate of 1895 we find that the amount set down in cubic yards has been increased 50 per cent over that in 1890. That was very gratifying to us, because it showed the change in a wholesome direction, and we would liked to see that continued, in a way; but we could not find anywhere that anything was fixed or settled; there were no detailed drawings of construction anywhere along the line. There were no definite drawings of the great locks which the company proposed to build, or statement of the materials of which they were to be composed.

At one place it said they were to be built of concrete and stone masonry, and in another place of masonry and iron; but when we came to examine them we found that they were to be composed exclusively of six-dollar concrete, and there was nothing said about cut stone at $20 per cubic foot; yet there was a disposition to be accommodating.

Then we found that a change at the last moment had been made in the site of part of the San Francisco embankment line. They believed at last that they had found a better place for that. They also moved the third lock, coming from the Caribbean Sea westward, to a new site; but no borings had been made to determine the material. There were other things of that sort. Everything was still "under consideration."

I find in this testimony half a dozen distinct changes in their propositions. There is a series of changes about the project, and I would like to refer to them because they are of the utmost importance and have a positive bearing upon this inquiry. In the first place, we have always supposed from the beginning, as you will see in our report, that the summit level of the lake was to be held at a fixed minimum of 110 feet above sea level. The depths were to be measured below that level in the lake and river, and we supposed that 110 feet above the sea was the minimum point to which the lake was to be permitted to fall.

Now, we find the strange assertion that this summit level is not fixed. We supposed that 110 was the minimum, and now we find that the lake may fall below that. That is stated since our report was made in which we indicated the difficulty of regulating the summit level; but the chief engineer now says that after all it will be quite possible to permit the summit level to fall 1½ to 2 or more feet, because in the San Juan River, where the channel is to be 28 feet deep, it can go back 1½ or 2 feet and still have 26½ feet. The report says this is sufficient for a commercial canal.

Furthermore, it is said that our naval war ships are not intended to go through there; that it was not the purpose to build this canal for the use of the United States men-of-war or battle ships going from the Atlantic to the Pacific. We had been under a different impression. We had been under the impression that our vessels were to go through there; but this is not to be. Then what becomes of the patriotic and professional interest shown in this matter by the numerous naval officers who have concerned themselves in this? We ought to have 30 feet of water all through, and the locks ought to be 80 feet wide instead of 70 feet wide. Several of our battle ships can not go through with 70 feet.

Mr. CORLISS. In your estimates you have provided for the maintenance of the summit level at 110.

Colonel LUDLOW. Surely; how could a ship cross the Pacific, say from Shanghai, without knowing how much water she would find to

cross the Isthmus. Two to 4 feet would make a great difference. On the Great Lakes, 2 to 4 inches are serious. It is sometimes seriously detrimental to lake navigation if the depth falls off from 2 to 4 inches.

As to the variation of summit level, I apprehend no engineer, naval officer, or shipmaster would regard it as admissible in a work of this kind. I want to quote something in reference to this as stated in the testimony of the chief engineer of the company.

Mr. DOOLITTLE. Where do you find that statement?

Colonel LUDLOW. It is on page 69.

Mr. DOOLITTLE. Is that the verbal statement, or the manuscript statement?

Colonel LUDLOW. That is in the paper. It says:

The maximum fluctuation of the lake level, as near as can be determined from the information obtainable, is about 10 feet.

I may say that the company formerly estimated it at about 5 feet. The board were inclined to believe from what it ascertained that the range was 12 to 14 feet. We were satisfied that it was much more than 5 feet. This was first ascertained in Mr. Child's surveys. He was a very competent man, and was the first one to note the fluctuation of the lake, and he found it 5 feet, and the company took his estimate of it, which is an old one; but we found it was 12 to 14 feet, from the water marks on the banks. It is now 10, according to the statement of the company. One level he disregards, and he may be quite right about it. Then he says:

The flow of the river will be more uniform by reason of enlarged sectional area in the created storage reservoirs and lessened fluctuations of lake level; and with an intelligent management of the sluices and weirs, at both the western and eastern ends of the summit level, there is no reason why the lake should not be maintained within 1½ feet of the assumed 110-foot level, as proposed in the company's plans.

In the second paragraph, page 70, he says:

The board attaches considerable importance to retaining the lake level at or above 110, and believes that any fall from that level will be injurious to navigation in the river and canal. There is no foundation for that statement. The canal is projected to be, ultimately, 30 feet deep throughout from ocean to ocean, but in order to reduce first cost of construction the river section and the sea-level sections of the canal have been estimated with a depth of 28 feet, the additional 2 feet to be excavated after the canal is open to traffic. It is claimed that the lake level can be maintained within a range of 3 feet, or within 1½ feet of 110, and the board does not seem to dispute it. Should the lake fall 18 inches below the 110-foot level, the excavated channel in the river will yet have a depth of 26½ feet, or 6 inches more than the Manchester and Suez canals—

That is an error as to the Suez Canal—

and the sections of canal in excavation a depth of 28½ feet, or deeper than any ship canal in the world. That is to say, the lake may fall 2 feet below the assumed summit level, 110, and all the sections of the river and canal in excavation will yet remain deeper than any other canal now in successful operation, and there is no apparent reason why this canal should be made deeper than experience has conclusively shown to be sufficient elsewhere.

The lake, then, according to this, may vary even 2 feet. The summit level will be permitted to vary 1½ or even 2 feet below the assumed summit level.

Mr. DOOLITTLE. Do you gather from this statement of Mr. Menocal's that it is intended to permit such a variation, or does he simply mean that it may vary that much and yet remain deeper than any other canal—still have a sufficient depth?

Colonel LUDLOW. I understand that the supposition heretofore has been that means would be taken to maintain that summit level at 110 feet or more, not permitting it to fall below 110 feet. I say this idea of

Mr. Menocal's was an entire surprise to me, as it was to all of us. I had a brief conversation with Mr. Noble in New York, and Mr. Endicott conferred with us in Washington, and we all agreed that was the first time we heard of that proposition, and didn't believe such a proposition was ever heard of before.

Mr. DOOLITTLE. Still, no one would undertake to say what was in the minds of those gentlemen.

Colonel LUDLOW. That is true. I am not desiring to extend my criticisms further than what the engineering facts would warrant. I only say no canal was ever constructed on that basis. You observe, then, that the navigation ceases to be a 28-foot navigation as the level of the lake falls. It is assumed that the variation of the lake can be regulated within 3 feet. The board has serious doubts whether that is possible. Although we had rather limited material to work on in connection with this matter, you will find it argued in our report. We believe that the regulation of the level of the lake within 3 feet is a matter of extreme doubt. It is very doubtful whether it can be regulated within that figure. We do not know its maximum range. The board measured the water marks, but there is still an uncertainty about it. We believe it varied as much as 14 feet.

Mr. ENDICOTT. A little over that.

Colonel LUDLOW. Mr. Menocal in his statement here admits, for the first time, that the fluctuation of the lake is about 10 feet. Should it be 10 feet, what then? Suppose you can not regulate it within 3 feet. Suppose you can not regulate it within less than 5-feet range. That variation has to take place, above and below. You might stand the increase, but can you stand the 2 or 3 feet of loss? I think not.

Mr. DOOLITTLE. At all events, you suppose the excess can be taken care of?

Colonel LUDLOW. No; there would be another serious difficulty.

Mr. DOOLITTLE. But not beyond engineering skill to control?

Colonel LUDLOW. I believe not.

Mr. DOOLITTLE. The river takes care of it now?

Colonel LUDLOW. Yes, with a lot of surprises in it.

Mr. DOOLITTLE. There are always surprises about high water.

Colonel LUDLOW. It depends upon how high you get it. As we measured the range of the river there, the company assuming a range of 5 feet, we determined beyond question that the river had risen 21 feet, because the residents pointed out to us where it had covered the track on a siding on the bank of the river which measured 21 feet above low river.

Mr. DOOLITTLE. That river does not rise as much as the Ohio River?

Colonel LUDLOW. No.

Mr. SHERMAN. Who pointed out this to you?

Colonel LUDLOW. We inquired about all such matters at every point where we had an opportunity to make an investigation, and we leveled ourselves in this case from the bench marks, you might call them. We would get the station master to indicate how high water had been and make our measurements accordingly. The station master would say, "The water came up on this sill," and then we could estimate how high it was. We did this; pursued this course at every point where we could do so.

Mr. JOY. At what part of the river did you find that excessive high water?

Colonel LUDLOW. At Machuca, about 18 miles above Ochoa Dam, at the Machuca Rapids, upstream toward Lake Nicaragua. We found

elsewhere marks that would range 14, 15, 16, and 18. This was the highest we saw. I think it was 21 and something. It was a great surprise to us. We were not prepared to find that, because the river had always been referred to by the company as equable, and one particular fact that was urged was that it was not subject to floods. It is declared over and over again in the canal reports that the river is not subject to floods. That depends, then, on what you call a flood.

Mr. JOY. Did that high water result from excessive rainfalls or from the lake itself?

Colonel LUDLOW. You know the river is made by the flow out of the lake.

Mr. JOY. But the rainfall would have something to do with it?

Colonel LUDLOW. Certainly; there might be a heavy rainfall over the lake which would fill the Upper San Juan very full, and there might at the same time be a flood in the San Carlos, which is a very desperate stream indeed at times, as is admitted by everybody who has looked at it. It is subject to heavy rainfall and floods. It pours off of those mountains 40 or 50 miles away, and tears down with violent oscillations. That is the character of the San Carlos River. Beyond question, when you have high water in those two rivers and they come tumbling in you get a rise. In the Machuca Rapids the water may have risen very high. It was dammed up there, as it were. It may not have been as high elsewhere. I do not believe it was. We do not know. We have not any figures.

I do not want to detain you on this point any longer. Another new point is this: This project is always referred to as having been fully worked out—that is, that the information is complete; that all the reports are complete. We find now for the first time that it is admitted that it is not complete; that the reports are not complete, were not regarded as complete. The project is not "final," but "original," or "approximate," or "preliminary." Phrases of that kind are used, which shade off the meaning very considerably. If the company had frankly said to us, "This is a preliminary project; it still remains to be completed, and we recognize the fact that there is much information to be had," it would have abbreviated our labors a great deal, because we proceeded on the idea that the information was complete.

The next point I was going to touch on I think must be a misprint. Mr. Menocal speaks of $3,000,000 as the estimated cost of the Ochoa Dam.

Mr. PATTERSON. "Inside of $3,000,000" was his answer.

Colonel LUDLOW. That is the text; but I was sure that must have been a misprint, because, if you will observe, the company's estimate of 1890 made the cost of that dam—which was the project we had to consider—$726,000. We had to consider the building of a dam there for that sum. We did not believe a dam could be built there for $726,000, whether the water ran over it or under it. We had some very serious discussion on that matter. While we were considering it last summer, the company made a revision of its estimates, in order to include certain matters, which had to be carried forward into the total cost, and the estimate for the rock sections of the Ochoa Dam was increased 50 per cent, and the cost, as estimated in 1895, was $977,000. Now, I say I could not account for the fact of an estimate, based on developments since last summer, of a sum of $3,000,000. That seemed to be an abnormal change. While the direction of the change was wholesome, I could not account for such a sudden and extensive change.

Mr. SHERMAN. In your report, did you not suggest material changes in the construction of this dam?

Colonel LUDLOW. Oh, yes; very grave changes.

Mr. SHERMAN. Possibly Mr. Menocal, in changing his estimate of the cost of construction, had in view the dam which you proposed?

Colonel LUDLOW. He comes within $1,000,000 of our estimate now. We did not pretend to make a careful estimate, although we did the best we could under the circumstances. We put down $4,000,000 as the sum within which the dam and its appurtenances could probably be constructed. I did not understand Mr. Menocal's estimate of something less than $3,000,000. I thought it proper to call the attention of the committee to the fact.

Mr. WANGER. It is possible that Mr. Menocal was referring to the cost of one section in giving that answer.

Mr. DOOLITTLE. The question was: "At what do you estimate the cost of the Ochoa Dam?" and Mr. Menocal says, "Inside of $3,000,000."

Colonel LUDLOW. I do not know what those figures should be. I think it is a very wholesome approximation to what may be the cost of that dam. We estimate it roughly at $4,000,000.

Mr. STEWART. You started out by stating that you would refer to some facetious remarks on the part of Mr. Miller. Now you have lost sight of that matter.

Colonel LUDLOW. I think not, because I propose to come to it. I am much obliged for your suggestion. I think what he said was intended to be facetious.

On the next page, page 60 of the testimony, Mr. Menocal states it is proposed to give the dam a base of about 1,000 feet. That again would indicate that he was approaching to the increased cube which the board has recommended, because the base of the dam as previously stated was to be 500 feet. He has increased that to 1,000 feet.

Mr. DOOLITTLE. Would that be the length of the dam?

Colonel LUDLOW. Up and down the stream. No, the length of the dam across the stream is a fixed quantity.

Mr. DOOLITTLE. Still it would be built in the soil on each side.

Colonel LUDLOW. Yes, it must be, and go deeply into it, with very careful protection to prevent the river from flanking it. That is the point of weakness in a dam. That would be the weak point in a masonry dam as well, if in other respects it was adequate.

There is another point I would like to refer to. That is a proposition which struck all the members of the board as entirely novel. It was never heard of before; and that was that the chief engineer, in lieu of that La Flor Dam in the Pacific division, which the board regard as impracticable, and for which they would substitute a common, ordinary low-level canal in excavation, it now appears that another proposition is assumed—don't know when—and that is that the question of building a low-level dam and basin has been worked out. And at one point in the text our board is reproached for having hastily disregarded that proposition altogether, not considered it, and rejected the high-level dam, and adopting the low-level canal, without regarding this question of a low-level dam at La Flor and a low-level basin.

I assure you that it is a question that is absolutely novel. It has not heretofore been suggested, and it has not been thought of before so far as we know or can get any indication from the company's reports. That was another change which we, of course, have not considered at all. I would not regard it if they had, because there is no use running any chances on that western division. It is a good, honest division, and you can build the canal there beyond question, and to run into any costly or risky experiments with a thing of that magnitude would not

be justifiable, unless there was some adequate compensation for the risk, and in that particular case the adequate compensation does not exist. If you abandon a high-level dam you simply lose 4 or 5 miles of basin and substitute for it 4 or 5 miles of an ordinary canal, and the disadvantage of doing so is not sufficient to warrant you in taking any great risk in tryiug to do the other thing. That was the view the board took of it.

There are a lot of references all the way through this testimony of Mr. Menocal to the effect that the ablest engineers of the United States and England have said his plans were practical, and that the cost can not exceed so and so. I think I have covered that sufficiently without adding anything further. We have looked at the report of the "American board" and at the letter from Mr. Donaldson, who, so far as we can ascertain, represents the "English board." At any rate, he does so in Mr. Menocal's view.

There is one other subject I would like to speak of. It is the question of the San Juan River—the survey and estimates of the San Juan River. The company's reports allege with regard to that—make no exception of it, at least—that it has been thoroughly investigated. We found an extraordinary discrepancy between our figures, as we were able to make them, and the company's figures on that point, and there are some remarkable statements with regard to this matter.

It was Mr. Miller, I think, and also Mr. Menocal who intimated that we intended to disparage the report made by the Lull survey of 1872. I can assure you that nothing was further from the purpose of the board. The Lull survey expedition was a preliminary expedition. Their primary purpose was to confirm the survey made by Colonel Childs twenty years before, and they did not undertake to make a careful instrumental survey of the San Juan River. They measured around the falls with transit and level, and for the rest made a boat and gradienter survey of the river, took soundings in it, and determined its general depths, channels, etc., and among other things got indications with a lead of the nature of the bottom. The leadsman called out "gravel," "sand," "rock," and so on, as well as he could determine. Now, there has been no further investigation made of that river. The expense of deepening it is one of the most serious items in the entire project, and the variations in cost for the different sections of the river are great.

We asked the basis of the company's estimate. They furnished us a profile of the river—a longitudinal section, if you like—which they said was the basis for estimating. It purported to be, as they believed it to be, a longitudinal section or profile, derived from the Lull survey. What was peculiar about it at once was the fact that the profile as drawn did not confine itself to the depth of water and to the surface indications, but penetratad deeply into the bottom down to the bed of the future canal, and on this profile were indicated with apparently remarkable exactness all the various materials of which that river bed was composed. Now, as a matter of fact, there is not a particle of authority for that profile. The Lull survey did not go farther than the bottom of the river. They did not attempt to penetrate below and ascertain the character of the bottom, and nobody has been there and made such investigation since.

Mr. DOOLITTLE. Was that profile presented to you by the company?

Colonel LUDLOW. Yes, it is a part of their records; and when you choose to examine the plans and maps accompanying our report you will find that submitted. They made no concealment of it, nor was there any reason why they should. But when we had the computations

checked we found an extraordinary discrepancy between the figures we made and the figures they made, a discrepancy that was extraordinary and unaccountable. We assumed the figures given us, as we always did in such cases, and then checked them off and recomputed. We had the services of Mr. Bennett in this work, a very capable and honest fellow, who was in and out of our office almost every day, going to and fro with the maps and drawings and plans and really was at our disposition, although his business was that of custodian of the drawings of the company which we were using. In this case he went over the computation and confirmed our figures. Then, naturally, we asked how such a thing happened. Well, there has been an error of some sort, an inadvertence. It has been carried over from some previous error. The curious part of it is the comparative unwillingness of the company to admit that there was an error.

On page 71, Mr. Menocal says:

> Borings in the bed of the river, where excavations are needed, would have been of much interest and value, but the discrepancy in the estimates, due to the omission of such borings, may be safely counted on the right side.

I must say I do not quite understand what that means, except that it tends to attribute the errors to the omission of borings.

On the previous page, Mr. Menocal says, at the bottom, that they intended to make a more detailed survey of the river. That was evidently their purpose. He goes on to say:

> This omission has not, however, the importance attached to it by the board.

Because there was no question as to the entire practicability of that portion of the canal, and so their engineering force was kept employed on other matters—rectifying locations, etc.—until the work was suspended, and they found the river work undone.

Now I turn to page 78. It is rather odd that this discrepancy, although referred to in two or three places, has not at any other point been readily explained, and, curiously enough, you find the explanation of it not under the head of the San Juan River, but under the head of Lake Nicaragua, on page 78, where you would not look for it, and it takes up half that page in a statement as to how those discrepancies occurred. There it states:

> It now appears that through clerical error, mistaken computations, or misprint in the preparation of that report the quantities estimated fall short of the actual amount of excavation needed, and it is conceded that the estimates must be corrected accordingly.

Mr. STEWART. There is one instance where he frankly admitted the error?

Colonel LUDLOW. Yes; it could not very well be overlooked. It was an error the correction of which increased the estimate of rock excavation from about 400,000 yards to 1,400,000 yards.

Now, on pages 81 and 82, at the bottom, Mr. Menocal says:

> As regards the San Juan River, it has been stated before that the company had the free use of the surveys made for the Government by a corps of competent officers under Commander L. P. Lull, United States Navy, in 1872–73. There is nothing to suggest the belief that any material changes have taken place in the channel since that date, or that a new survey under the direction of the board would add much of practical value, etc.

In one place he admits that the survey ought to be made, and here says that if it was done under the direction of the board he has doubts as to its value—which might have been differently phrased. I believe that is as much as I care to say on that point.

I have referred, I think, Mr. Chairman, to the fact that notwithstanding elaborate surveys and the amount of time and money spent in the surveying and leveling of the section from Ochoa to Greytown there is still an uncertainty or discrepancy of 1 foot in that leveling. I do not know whether I have referred to that. There is an admitted uncertainty of 1 foot of level between those points which has not been satisfactorily cleared up and which they at least sought to amend by running another complete line of double check levels from Greytown to Ochoa. Mr. Bennett was in charge of the work at the time the parties were finally withdrawn. That 1 foot might make a great difference—a foot less depth, for example, in making that great cut through the Eastern Divide or in the River San Juan would be a matter of importance. A foot, more or less, would mean in that case quite a sum of money, certainly enough to pay for the survey. That is where the advantage of preliminary and full information comes in.

Now, as to the doings of the board while in Nicaragua. That is a matter which is more personal, and which is very disagreeable to treat of, Mr. Chairman, but with the indulgence of the committee I will touch upon it, as it seems to be a necessary point to speak of.

Mr. SHERMAN. Mr. Endicott went over that in his statement before the committee.

Mr. DOOLITTLE. And Mr. Noble also went over that subject.

Colonel LUDLOW. I am quite at the service of the committee, gentlemen, but there are some things I will have to explain.

I find the statement in Mr. Menocal's testimony that we did not stop at the site of the Ochoa Dam; that we passed right by it, although he had prepared a camp there for a six days' stop.

Mr. STEWART. They went over that matter fully.

Colonel LUDLOW. If the committee is satisfied, I have nothing more to say.

The CHAIRMAN. Pursue your own course as to what to say.

Colonel LUDLOW. Of course, I do not know what my colleagues stated, and am at a loss as to what ground to cover.

Mr. BENNETT. Because you have not heard them, you are a better witness.

Colonel LUDLOW. I may say, and I may not say, the same thing that they did, but this ground will have to be covered. It is a matter which has its serious aspect. I referred briefly to one or two things Mr. Miller said. He is not primarily responsible for them, as he got the information from others. He states that from information from persons he believed to be wholly qualified to speak the commission spent only from twelve to fourteen days on or near the line of the canal.

He evidently gets that from someone else. I had an intimation in London before I came over here. I saw a clipping—had arranged to have clippings sent on to me—in which it was intimated the company was prepared to meet the report of the board; that Mr. Menocal had been keeping a diary and that at the proper time it would be shown what sort of an investigation this board had made; and I have been waiting with some interest to hear what those revelations would be. I would briefly state that the undignified travesty of the account of what the board did down there is an unfortunate way of trying to meet the force of the engineering arguments and statements which are embodied in our report. It may be that our investigation was incomplete. We know it was and said so. But we did the best we could in three months, and we had a very important mass of work behind us, which is not referred to in Mr. Menocal's statement, and that is the three months of work after our return, in the investigation of the company's data.

Our trip to Nicaragua was to familiarize ourselves personally with the country and the people and physical and moral conditions under which people would have to go there to do this work. Because we had not always lived in the Tropics, or had not been to that country before, was no reason why we should not be good observers, since we came from the same country probably from which other people would have to come in order to inhabit the country and build the canal if it were to be built. Much stress is laid upon that point, and other things more serious. Mr. Miller says, for example—it is facetious, of course—that "I was sent abroad to investigate other canals, and it would have been better if I had been sent abroad first."

Mr. SHERMAN. I do not think Mr. Miller was especially facetious in anything he said here.

Colonel LUDLOW. Wasn't he? Personally I do not feel offended at all, but I have my own way of treating those questions and can not agree with him. Probably if I had been sent somewhere else some other person would have been sent to Nicaragua with the same results. I do not know where he gets his information about our spending twelve or fourteen days there. He said we did not stop at the site of the Ochoa Dam.

Mr. DOOLITTLE. That was on your way over, if I may correct you.

Colonel LUDLOW. There is no indication of that in the testimony.

Mr. DOOLITTLE. Mr. Menocal's statement was that you did stop on your way back.

Colonel LUDLOW. He says we did not stop there at all.

Mr. JOY. That is, he said you did not stop going over.

Colonel LUDLOW. Let me look at that. Mr. Miller says, on page 22:

The Commission spent from twelve to fourteen days on or near the line of the canal. They never made any surveys of any kind. They never even stopped at the site of the Ochoa Dam, and of course the Commission could not have made a survey. They could not make any survey that would be of the slightest use without two or three years' time with a corps of engineers.

Now that is a definite statement; that we never stopped there.

Mr. JOY. We were referring a moment ago to Mr. Menocal's statement.

Colonel LUDLOW. That is from the record, and I have no other means of knowing what was said than that. I want to find a similar statement by Mr. Menocal and see if there is any qualification in that. I know there was a qualification in Mr. Menocal's statement.

Mr. CORLISS. He stated that on the return they stopped several days.

Colonel LUDLOW. I have not that, but I will briefly run through those things. I will continue with Mr. Miller. I hoped I had some memoranda with regard to that, but I do not find any.

Mr. Patterson asked, for example, whether any competent engineer in possession of the maps and profiles and all the data could not have made this investigation and report as well in his office in Washington as by a trip to Nicaragua. Mr. Miller agreed entirely that he could.

Mr. PATTERSON. Beginning on page 62, Colonel, I find the following:

Mr. DOOLITTLE. Before you proceed with that allow me to ask one question. Please state about what length of time the engineers spent at the Ochoa Dam, and tell about the examination that was made there at the site of the dam?

Mr. MENOCAL. Not any. They did not examine the site of the dam. They passed by it.

Mr. BENNETT. If they passed by such an important piece of work, estimated to cost millions of dollars, without investigating it, what would their investigation amount to?

Mr. MENOCAL. I am not prepared to answer that. I can only say they passed by there. I had fixed all their camps, so that they would have an opportunity of examining the most important sites, and one of the camps was at the Ochoa Dam itself.

They slept here two nights, and, as I said, they wanted one day to examine the adjacent hills. I had a camp here [exhibiting on map], and six days provisions, and a number of engineers. They arrived in the afternoon and looked around for half an hour or so and came back to the camp. I sent the boats here to bring them back [exhibiting on the map], and on the following day they found them here and brought them back, and they arrived at the camp about 4 o'clock in the afternoon. The next morning they started to look over the line of the canal and never had any time for an examination of the site of the dam.

Mr. STEWART. Mr. Menocal says, on page 59, that they landed at Ochoa in the afternoon of one day about 2 o'clock, and looked around a little, visited the ocean, and the region of the San Carlos Basin south of Ochoa.

Colonel LUDLOW. That could not be so. I do not understand that, for we were 30 miles from the ocean one way and 140 the other.

Mr. STEWART. Mr. Menocal says they spent one day going and one day coming back, and on the second day they arrived and next morning ran across to Greytown; they were six days in that section.

Colonel LUDLOW. Yes, sir. But the complete statement, as made elsewhere, has no such qualification in it whatever, and I should say that no one could read that statement and believe the board made any investigation at the site of the Ochoa Dam.

Mr. STEWART. All the testimony should be taken together.

Colonel LUDLOW. But we can not find it all together, unfortunately.

Mr. DOOLITTLE. Mr. Menocal said he was speaking without notes.

Mr. CORLISS. He did not read any narrative.

Colonel LUDLOW. If you will permit me, I will go over this in accordance with my notes. We will take the pages as they come. There is not very much of it in quantity, although there may be very much in quality.

Mr. Miller's engineering, if it is correctly reported, is the wildest I have ever read. He is an engineer of great and varied accomplishments. He does make one remark which strikes to where it belongs. He says that anyone can go along and note high-water marks on the banks. I suppose everybody will agree with that. The only thing that astonished us was that the company had not done it. We did it. Mr. Miller says the rise and fall is 5 feet. He has only to go down there and examine the banks, and according to the least estimate he will find that it is 15 feet.

Mr. BENNETT. How long were you at the Ochoa Dam?

Colonel LUDLOW. Three days.

Mr. DOOLITTLE. Mr. Menocal says that.

Mr. BENNETT. Have you notes of your investigation and observations?

Colonel LUDLOW. Oh, yes; notes of everything. Everybody kept notes. We would be poor investigators if we did not keep our notes. And furthermore, if you please, the board took the trouble to furnish a copy of the minutes of the board, which gives our daily movements and whereabouts, although not very fully; we did not want to make it elaborate. The minutes tell where we went, from one point to the other. That is one of the appendixes.

As a matter of fact, we got there Sunday at noon; I do not remember the day of the month. We landed there Sunday at noon and found an elaborate camp there ready for us. The camp was fixed up very handsomely, and it was very interesting, being constructed by the natives with wood cut out of the forests. There was not a nail in it. It was a fine bungalow that would have lasted all summer. It was water-tight. There were two or three of those, and they were very neat in appear-

ance. We landed and spent the afternoon in exploring the vicinity on that side. This camp was at the site of the dam—right at the site of the dam. We went over the hill against which the canal abutted. We went out on the crest line and crossed over to the canal line, where they were divergent, and made a thorough examination. In fact, I never did a harder day's work than that.

Mr. BENNETT. For a superficial examination, do you believe you spent all the time at the Ochoa Dam that was necessary?

Colonel LUDLOW. I know we did, and we did more than any one other engineer has ever done. We saw the whole of it. The San Carlos ridge is a very important feature, a very essential continuation of that dam. Unless you go out on that ridge and fill up depressions you can not build the dam at all. I mean there would not be any dam.

Mr. SHERMAN. You say you are the only engineers that ever saw the entire line of this canal?

Colonel LUDLOW. I mean the only ones who have gone over the whole of it without any serious gaps in it.

Mr. SHERMAN. You mean Mr. Menocal has not gone over it?

Colonel LUDLOW. I mean, from information I regard as absolutely reliable—although, of course, not of my own personal knowledge—that we took Mr. Menocal, not that he took us; that we took him over the embankment line, which is the dangerous part of the San Francisco division, through those dangerous hills; that we took him over several miles of that line which he had never seen.

Mr. SHERMAN. What do you base that statement on?

Colonel LUDLOW. On positive statements from people who knew.

Mr. DOOLITTLE. Statements from whom?

Mr. SHERMAN. That is a very serious statement.

Colonel LUDLOW. I would like to supplement it further by stating that according to the best of my knowledge and belief, and from similar information, that Mr. Menocal had never been over the crest line of the San Carlos ridge. We went over that crest line, and it was credibly stated, and I believe truthfully, that Mr. Menocal had never been over it. I have no doubt of that myself.

Mr. DOOLITTLE. By whom was this statement made?

Colonel LUDLOW. By a gentleman who had been employed with the company——

Mr. DOOLITTLE. What was his name?

Colonel LUDLOW (continuing). A trusted engineer, who remained, as I understand, until the close and then drifted off, went off into other employment. We engaged him, on account of his knowledge of the country and his familiarity with it, to go down with us and help us out.

Mr. DOOLITTLE. Did you ask Mr. Menocal whether he had or had not been over this ground?

Colonel LUDLOW. No.

Mr. SHERMAN. What was this engineer's name?

Colonel LUDLOW. Davis.

Mr. SHERMAN. Did he have some difficulty with the company?

Colonel LUDLOW. As to that, he may or may not have had. I do not know. I believe they had some differences toward the end, but I do not know. As I recollect it, he was retained until the close. He was manager, I understand, of the steamboat line.

Mr. BENNETT. Relations friendly with Mr. Menocal?

Colonel LUDLOW. They were. I do not like this, gentlemen.

Mr. STEWART. Were Mr. Davis's relations friendly?

Colonel LUDLOW. There was absolutely no indication of any personal

unfriendliness, and we had not any, any more than I referred to this morning.

Mr. STEWART. Did Mr. Davis express any hostility to you to Mr. Menocal?

Colonel LUDLOW. No. You do not understand that there was any quarrel [addressing Mr. Endicott]?

Mr. ENDICOTT. No, I do not.

Mr. DOOLITTLE. I would like you to state to the committee whether or not you regard that as a friendly statement coming from Davis against the engineer of the company.

Colonel LUDLOW. I think it is a statement of fact.

Mr. DOOLITTLE. Do you think it was a statement of a friend?

Colonel LUDLOW. I do not think it was friendly to do it.

Mr. STEWART. Would you base your opinion upon unfriendly, hostile testimony?

Colonel LUDLOW. I stated that was my belief.

Mr. BENNETT. Your statement this morning was positive.

Colonel LUDLOW. I desire, if you please, to check that. It was impossible that I should know it myself.

Mr. JOY. Were these statements of Mr. Davis made before you went to the Isthmus?

Colonel LUDLOW. No; they were made on the ground.

Mr. JOY. And he was with you in your investigation?

Colonel LUDLOW. Yes.

Mr. DOOLITTLE. Was Mr. Menocal present?

Colonel LUDLOW. No, I think not; it was in the camp; everybody was there.

Mr. DOOLITTLE. Not communicated to Mr. Menocal by you?

Colonel LUDLOW. No, sir.

Mr. SHERMAN. Would you have given as much credence to what he said had you known he was not on friendly terms with Mr. Menocal?

Colonel LUDLOW. I don't know. I believe he is honest.

Mr. BENNETT. Would you have given as much credence then?

Colonel LUDLOW. I believed it then.

Mr. STEWART. Did he speak in a way that was derogatory to him as an engineer?

Colonel LUDLOW. It was not derogatory to his capacity as an engineer at all. It would have been quite possible that Mr. Menocal, being in charge of so much work, should find it impracticable to go over every part of the route and country along the route.

Mr. BENNETT. Then you don't consider it a criticism?

Colonel LUDLOW. I do when it comes to criticising us for not doing it.

Mr. BENNETT. You must be fair.

Colonel LUDLOW. I say I consider it a fair criticism when he criticises us for not doing it and makes a false assertion in so doing.

Mr. JOY. Where did you find Davis?

Colonel LUDLOW. In Washington.

Mr. JOY. You took him with you, did you, from here to the scene of the operations?

Colonel LUDLOW. Yes, sir; we engaged him just as soon as I found he was unemployed, and that he had been down there.

Mr. STEWART. Don't you know that Davis was not there at all until 1887?

Colonel LUDLOW. I don't know.

Mr. STEWART. And that Mr. Menocal had been there many times before?

Colonel LUDLOW. Oh, yes.

Mr. STEWART. Could he not have gone over this before Davis had seen Nicaragua, assuming Davis had not been there?

Colonel LUDLOW. No, because that line had not been located at that time; he had not located that crest line.

Mr. STEWART. You are sure of that?

Colonel LUDLOW. Yes, sir. It is all simple enough, except that Mr. Menocal travesties the whole thing; and if you will read his statement you will see that he was trying to guide us, and we had a disposition to wander off in the woods, and go in bathing, etc.

Mr. STEWART. Don't you think it was your duty, as a fellow engineer, to call to the attention of the engineer this criticism of Davis?

Colonel LUDLOW. No, sir; I do not, indeed. It was Mr. Menocal's own affair if he had not been over the line. I found no fault with it. I had no thought of making any such statement as I have made with regard to the thing at all until I find he is travesting this thing. He is undertaking to make us ridiculous in the eyes of the world and the engineering fraternity.

Mr. JOY. Did Davis give you his means of knowledge of this?

Colonel LUDLOW. He said it was of his own knowledge. He stated so as a fact.

Mr. JOY. And by that you understood he had been with Mr. Menocal all the time on the line of the canal?

Colonel LUDLOW. He stated as a fact that that portion—I forget just where it was; it was a part of the San Francisco embankment—that Mr. Menocal had never been over it himself.

Mr. DOOLITTLE. Will you point that out on the map, if you can remember what portion of the line it was?

Colonel LUDLOW. It was the embankment line between the San Francisco and the Danta.

Mr. DOOLITTLE. Between what points?

Colonel LUDLOW. The Danta and the Nicholson. I think I have a note of it myself made at the time; but I thought nothing of it, I assure you.

Mr. DOOLITTLE. What distance would that be?

Colonel LUDLOW. I suppose it would be a matter, as I understand it, of 3 miles, or something like that, but a very difficult piece. It happens to be a specially difficult piece of that country.

Mr. STEWART. Did Davis claim to be in charge of that section when he was under Menocal?

Colonel LUDLOW. I don't know. He was in their confidence, as I understand it, and their manager.

Mr. STEWART. Did he tell you he was in charge of that section?

Colonel LUDLOW. I did not investigate that at all.

Mr. JOY. You took his statement without any investigation?

Colonel LUDLOW. Surely; I simply made a note of it.

Mr. JOY. And you make the statement here that you believe it to be true without making further examination?

Colonel LUDLOW. Surely. How should I go to investigate a matter of that kind?

Mr. JOY. There are several ways—if you ask me the question.

Colonel LUDLOW. It still can be investigated.

Mr. JOY. But you did not investigate the statement?

Colonel LUDLOW. Not in the least.

Mr. STEWART. You would take Mr. Menocal's word as quickly as Davis's, would you not?

Colonel LUDLOW. Individually, I? Not at all.

Mr. BENNETT. You would before you read that testimony?

Colonel LUDLOW. Look here, gentlemen, hasn't the inquiry taken a turn which is extremely unfortunate?

Mr. JOY. It has taken a turn you have caused it to take.

Colonel LUDLOW. You ask me whom I would believe——

Mr. BENNETT. It is a question as to what you say and what Mr. Menocal says.

Colonel LUDLOW. No; does Mr. Menocal say he had been over that part of the line?

Mr. BENNETT. We have been led to believe it.

Colonel LUDLOW. Quite true, sir; you have been led to believe many things.

Mr. CORLISS. Colonel, where is Mr. Davis now. Where is he engaged now?

Colonel LUDLOW. The last I heard, he had gone to Costa Rica. Whether he is still there I don't know. When we were down there, he said he was going to Costa Rica after he got through with his employment with us. When he was in Costa Rica, Mr. Keith was there and said he wanted him in connection with some railroad work.

Mr. CORLISS. He is not a Government engineer?

Colonel LUDLOW. Oh, no; he was formerly in the employ of the District government here as an assistant engineer, I think in connection with sewer work, or something of that kind. I believe the man to be entirely honest. I really do not know about any controversies he had with the company.

Mr. Menocal says, on page 48, that the Commission was in Nicaragua altogether about forty days, which, I believe, is about correct. I do not remember exactly how long it was; the minutes of the board will show. Of these forty days, Mr. Menocal says, a total of two weeks, more or less, was spent in examining the canal route, or rather the canal route and vicinity. He says that some places they touched and others they did not. "These gentlemen traveled by the most comfortable methods, either through the woods or along the roads, so that they were only two weeks examining the canal from the Atlantic to the Pacific Coast. They were detained in Greytown both on the arrival and before leaving." He says we were only two weeks examining the canal from the Atlantic to the Pacific. I do not know that my colleagues have covered this.

Several MEMBERS. We would like to have your testimony.

Colonel LUDLOW. He says we were detained at Greytown a week; that they awaited the arrival of the steamer; that they had ordered their outfit, but the Commission arrived before the steamer containing the outfit arrived, and they waited a week for it; that then they cleared out and went up the river. The matter of fact was we were making a survey and examination of the harbor. If the steamer had come for us before it did we would not have gone. We were going up the river, taking the steamboat and going to the western division first, right up the San Juan, across the lake, making our arrangements on the west side of the lake for the inspection of the western division work, going to the Pacific first and from there coming back, so by that we would go to the farthest point first.

By that means we would have a general view of the route as we went over it. We would be getting views of the country; we would be examining the San Juan River and the Lake, and then we would work back over the route in detail, foot by foot, or any other way that

seemed necessary. We waited a week at Greytown, it is true, but while there we were doing perhaps the most important work we had to do. The result of the work in Greytown is shown in our report under the heading "Greytown Harbor." That gives what we had to say on this subject. We made an instrumental survey of the entire beach line, which had not been made before, for four or five miles from Greytown around the cape and northward, making an extensive survey there. Our purpose in running that line and in running interior lines and lines on the beach was to enable the officers of the *Montgomery* to make the hydrographic survey.

The offshore work was done in the boats while we were gone. They did this, and it made a very valuable chart of the harbor, quite indispensable. That is the kind of work we were doing while we were represented as waiting for this boat and clearing out as soon as we got it. The freight boat came down pretty soon with our outfit—a lot of provisions, and instruments, and other things—and then we went up the river. The river navigation had just opened for the season. Two boats came down together; one left on Monday, and we got off the next morning, Tuesday. We went up the San Juan River. Mr. Menocal said we traveled at night. We never traveled at night; we did not travel a single night.

Mr. SHERMAN. Where does he say that?

Colonel LUDLOW. He says it somewhere. It is a hard job to pick it out. I can find it if you desire me to take the time. If you see it I will be glad to have you call my attention to it. In the absence of the notes I have not the references to his testimony.

Mr. DOOLITTLE. On page 59, Mr. Menocal says:

> I must say that they ran lines around Greytown while they were waiting.

Colonel LUDLOW. He doesn't say it here in the place I am referring to.

Mr. DOOLITTLE. It says it on the next page.

Colonel LUDLOW. Further along; yes. He says:

> Then they went up the river and had to transfer in the river from one steamer to another at two different points.

As a matter of fact, we had to transfer at more points than two. He says further:

> There is only one steamer on the lake, and when they arrived it was not there, and the Commission had to stay two days waiting for this steamer.

So far, in his narrative, we haven't done an earthly thing that had anything to do with the canal. Continuing, he says:

> In those three days they made a trip up the river running south, and they also took a river steamer and went out into the lake and took borings and soundings.

As a matter of fact, we did more than that. We gauged the stream at Fort San Carlos, which the company had never done. We made an examination of the Frio River, which comes in in the immediate vicinity where the San Juan exists. We took great pains to get at certain bench marks at the confluence of the river and lake to indicate where the high water of the lake had reached.

Mr. DOOLITTLE. How can you say they never gauged the river at San Carlos?

Colonel LUDLOW. From their own records.

Mr. DOOLITTLE. Where did you find that statement that they never gauged the waters of the river at San Carlos?

Colonel LUDLOW. We asked them to furnish us with all the gaugings they had made and they did so, and we had them compiled on one sheet.

Mr. DOOLITTLE. You can not say positively that they never made any such gaugings?

Colonel LUDLOW. No record of any such thing ever reached the company, if you please, sir.

Mr. DOOLITTLE. You can state positively that the company had no information as to the river at this point, San Carlos?

Colonel LUDLOW. There was no record of the company having made any survey at that point. We asked the company to furnish us with all the records of the gaugings they had made, and they did so, and they told us at the time that those were all the records and gaugings they had.

Mr. DOOLITTLE. I know I have seen a statement as to the San Carlos.

Colonel LUDLOW. That is the company's gauging of the San Juan, near the San Carlos River. Fort San Carlos is a name of a station on the river at the lake——

Mr. DOOLITTLE. The waters of the River San Juan have been gauged repeatedly by the engineers of the company?

Colonel LUDLOW. Once.

Mr. DOOLITTLE. At different seasons of the year?

Colonel LUDLOW. Once and once only, and the record of that is defective to the extent that the level of the river when that gauging was made is not known. It was not, in other words, connected with the bench marks so as to say the river was at such and such a stage when that gauging was done. If it was, it would have been of great value.

Mr. STEWART. Mr. Menocal says, on page 60:

I told the Commissioners that the surveys and borings had all been carefully made; that I had an accurate record of them all; that a large number of men were employed in the work, and that I had engineers of experience to conduct the work. I was repeatedly told by them that they had no reason to doubt the accuracy of our surveys. I followed them step by step, with profiles, and maps, and plans, showing the results of the borings and surveys, and called their attention constantly to different parts of the route and very frequently invited them to verify those plans, maps, and surveys.

Colonel LUDLOW. We were all going in a group, yes; and Mr. Bennett went along and carried the maps, and we examined the ground as we went along, seeing whatever we could.

Mr. DOOLITTLE. Do you remember about the number of borings at Ochoa Dam?

Colonel LUDLOW. Perfectly. It is all in our report.

Mr. DOOLITTLE. There had been an examination of that kind made, sir?

Colonel LUDLOW. Why, certainly, they made some borings in the river bed and in the banks. We treat of that very fully.

Mr. DOOLITTLE. Mr. Menocal says that seventeen borings were made there, and that only two kinds of material were shown.

Colonel LUDLOW. Now, there is the difficulty, gentlemen. The 1893 Chicago paper, later than the final report of the chief engineer in 1890, states that the foundation would be gravel, clay, and rock, in the order named. He says the borings showed that as the foundation. We supposed that was the case when we went there to examine it. The matter is fully treated in our report. The only borings they made in the river, in the middle of the river, what would be the heart of the dam, were three or four or five, with an earth auger, not a boring in the sense of cutting into the bottom violently. The borings were with an earth auger, by the aid of a pipe, going down through the sand in the river bed. They went down 20, 22, or 24 feet and the pipe choked, and they

hadn't any means of getting any farther, and they never did get any farther; so all the information we have about the bed of the San Juan River at the Ochoa Dam from those borings, or otherwise, is that it is nothing but sand to an undetermined depth.

Mr. DOOLITTLE. Sand, clay, and gravel?

Colonel LUDLOW. No, sand; nothing but sand, from these borings in question. They do not go far enough to discover the deeper material, and they never found any rock there at all, although Mr. Menocal said he believed they struck bowlders. That is rock in one sense, but not in an engineering sense. The note book of the borings said "Believed to be rock," and the facts were they were sand in the river bed and bowlders in the banks. And that made the problem more difficult when we came to consider the question of the Ochoa Dam. Instead of having rock to base this work on, there was an undetermined depth of sand there. All that was known about it was that it was 20 odd feet in depth, and what there was below that nobody knew. I observe by these papers in testimony that Menocal accepts that proposition. But the borings had been already made sometime before that.

On page 59, Mr. Menocal says:

I had instruments at places to verify everything and they had some also, but no surveys were made.

He had instruments at all places to verify everything! I don't know what that means. He didn't have any instruments there to verify borings. We could not have used them if he had. We had instruments of our own. I do not know whether we used our instruments or his; I think ours. In going up the San Juan River, wherever we believed information was to be obtained we would check off on the bench marks, and make observations in the vicinity of the river which we regarded as important. We made gaugings of the San Juan River and all other streams at numerous points, and we determined the bench marks—the water marks on the bank—in order to determine what might be the variation of the river, and we found instead of it being 5 feet, as assumed, it was not less than 15 feet. In one place the information was very clear that it had risen at least 20 feet.

I do not want to go too far on this subject. I came here at the request of the committee, and do not want to be tedious. I will go over this journey. We went up the San Juan River, and we were destined at first for the Pacific division. When we arrived at Lake Nicaragua, we stopped at San Jorge, which is a wharf and landing for Rivas. We landed our party there in charge of Mr. Davis, and his business was to collect the necessary animals for the use of the party in going over the western division. On that part of the route we could use animals.

Mr. DOOLITTLE. Before you go into that, I would like to ask you how long you had known Davis before your employment of him?

Colonel LUDLOW. I found I had known him when I was Engineer Commissioner of the District, and he had been employed in the District office among many others.

Mr. DOOLITTLE. How did you come to employ him?

Colonel LUDLOW. I think that he met Mr. Noble or met me, and made some inquiry as to going to Nicaragua, and said that he would like to go.

Mr. DOOLITTLE. I would like to ask you a further question. It is this: Do you know of Davis having any trouble in his employment here—any difficulty here—when he was in the employment of the District government?

Colonel LUDLOW. I have never heard of any trouble that he had here.

Mr. DOOLITTLE. I am informed that he got into difficulty when he was here.

Colonel LUDLOW. I don't know about that. Of course, if he did, there is a record of it now in the District Commissioners' office.

We sent the party to Rivas to make preparations for the examination of the western division. We had an understanding with Menocal that the company would use its provisions for provisioning the camps on the eastern division and we would use our provisions to take up with us and distribute on the western division. It was a very nice arrangement. The company had gone to a great deal of expense in making the eastern camps and getting the provisions there, and were glad to use anything we had, of course, so we used what was needed for the western division, and turned the balance over to the company in part as far as might be to reimburse them for the provisions they had furnished in the eastern division. We left everything; turned it over to the company. We landed our party at San Jorge and ourselves went to Managua. We went there to pay our respects to the Government, and also to look at the lake, a matter of 40 miles, about, from San Jorge to Granada. We went to Managua, the capital, and arrived about 8 o'clock in the evening on the same day.

The President granted us a special interview the next morning at 9 o'clock, and we had the honor of presenting ourselves to his excellency. We took the return train at 10 o'clock and went back to Rivas. Mr. Menocal says we spent two or three days there looking up horses, and so on. We got to Rivas at night, and left the next morning. We spent no time hunting horses. Davis had taken the two days since we landed him getting horses. It would have been a serious omission on our part if we had not gone to Managua. The Government had sent commissioners to meet us at Greytown. They had received us with a salute of eleven guns, and the commandantes of the forts and garrisons called on us all the way across the Isthmus. It was all an evidence of good will, and it would have been grossly discourteous in us had we not gone there. It involved no loss of time, for while we were taking that day and a half the preparations for our trip over the western division were being made, and we object to the statement of Mr. Menocal, at the bottom of page 58 of his testimony, that "in the evening they arrived at Rivas, 3 miles distant, and there they stayed two or three days hunting horses and other means of transportation to go over the line of the canal." There is no mistake about this statement. At the bottom of page 58 he says:

> They went to St. George, on the other side of the lake, where they landed and went to the capital to visit the President. Next day, in the evening, they arrived at Rivas, 3 miles distant, and there they stayed two or three days.

We left the next morning. Mr. Davis was down there making these arrangements. That is what he was sent there to do.

Mr. DOOLITTLE. Don't you notice Mr. Menocal said that he was speaking without notes?

Colonel LUDLOW. I decline to accept that as an execuse. A man before a tribunal of this kind should be held to account for what he says. If he wants to say those things he should first consider them. A man ought to tell the truth; I am not disposed to be unduly hard about this.

Mr. DOOLITTLE. It would not have been anything wrong if you had remained there six days.

Colonel LUDLOW. No. It is not material, except that Mr. Menocal is endeavoring to disparage the force of our report by disparaging the conduct and efficiency of the men who made it, and to show that we were a lot of stupid fellows, who didn't know how to do anything and didn't do it; whereas we did know how and did do it, and were doing it our way. And we are content to stand on the record. When Mr. Menocal holds a commission in the United States service, and when he comes here or anywhere else and makes such assertions, he must justify his statements or withdraw them or take the consequences. This is not the court of last resort in this matter. Perhaps I am in error in even discussing this question before you, but it is with this purpose. I was reluctant to believe that a man with whom we had associated—and whatever he may be, however interested in this matter, and however offended at what we may have to say—should have made such a statement. I thought that he would have recognized that there is no personal feeling in this matter as far as we are concerned; not a word reflecting upon him in our report. There are discrepancies—there might be anywhere—but we would not necessarily consider a man a villain who found them.

Mr. DOOLITTLE. That is true of every report; all kinds of engineering work.

Colonel LUDLOW. Is it not? Things must be impersonal.

Mr. DOOLITTLE. I say imperfections exist.

Colonel LUDLOW. Surely. And the longer time you take over them sometimes the more errors get in. I only wanted to say that I brought this matter up for this reason. It is not a personal matter. I have no controversy with anybody. We hadn't at the beginning. We hadn't while it was going on. We hadn't at the finish. No friction of any kind at all, until we are confronted with this most extraordinary testimony by Mr. Menocal before this committee, and we challenge it distinctly. I don't think I would have gone into the matter in extenso were it not that I think Mr. Menocal should have an opportunity of modifying his statement before it goes on final record. I venture to make that suggestion. It is in his interest and not mine.

Mr. STEWART. You might like to modify your statement as to Mr. Menocal not going over the entire route.

Colonel LUDLOW. Certainly, if I found myself mistaken.

Upon motion, the committee adjourned to meet at 2 o'clock the following day.

COMMITTEE ON INTERSTATE AND FOREIGN COMMERCE,
Wednesday, April 29, 1896.

The Committee on Interstate and Foreign Commerce this day met, Hon. William P. Hepburn in the chair.

STATEMENT OF COL. WILLIAM LUDLOW—Continued.

Colonel LUDLOW. Mr. Chairman and gentlemen, I do not know what indulgence the committee proposes to give me to-day, but I would like to make a brief statement in regard to the board, and then I would like, with the permission of the committee, to go over a little of Mr. Miller's testimony again——

The CHAIRMAN. Pursue your own course.

Colonel LUDLOW (continuing). I passed over Mr. Miller's engineering, not considering it seriously, but I learned yesterday from a member of the committee that he considered it seriously; and as his and Mr.

Menocal's testimony are to be taken together, I would like to go back. I want to say first, in regard to the attitude of the board in this matter, what might in a sense be a repetition, but it enables me to state the case briefly. We were appointed as Government officers to do a certain piece of work, with instructions to go and do that work the best we knew how and to come back and report the facts. The composition of the board was simple enough. It was in pursuance of the law which required the board to be composed of one officer of the Engineer Corps of the Army, one officer of the civil engineer corps of the Navy, and one civil engineer. I was indicated as the officer of the Corps of Engineers as, I believe, upon the recommendation of my chief, although I have no official information as to that; but I was selected, not by reason of any special or superior fitness to anybody else (I believe any officer of the Engineer Corps could have done the same work), but because I was in London and semidetached, and I could be sent without disturbing the work going on in charge of engineers of the Army.

The Corps, if you like, is proud of its repute, and I am glad to believe has the confidence of Congress and of the country, and I am sure no individual member of the Corps could be more solicitous for its honor and welfare than myself. We all share in that. Mr. Endicott is the officer who was selected from the corps of civil engineers in the Navy—an established corps which has done long and honorable service. What work they have done stands of record, whatever it may be, and will speak for itself. Mr. Noble is the civilian member of the board, and with regard to him perhaps I may be permitted to speak somewhat more freely. We were all three strangers to each other when this work began. We met for the first time in Washington. After a very intimate and thorough acquaintance night and day almost since the work began I can speak for Mr. Noble. He is one of the most capable, well informed, resolute, and resourceful men I know. He has courage and steadfastness, and he is sunlight itself for honesty, and he has a record.

It is Mr. Noble who, in conjunction with General Weitzel, of the Army Engineers, built the Sault Ste. Marie Lock, and since then he has been engaged on other important works. I doubt if there is a man in the body of civil engineers who stands higher. He built the Memphis Bridge, one of the most extraordinary and monumental pieces of engineering done in this country, and the engineers recognize him as the man who did it. He was there in the actual construction of the work. I may say, further, he is gifted with an inveterate modesty, and you have to discover his merits for yourself. That is the composition of the board. Now I will say, further, I do not believe that three men ever did more and harder work in the same length of time than we did. I know I never did, and I have worked pretty hard, too. It was a most difficult work. We understood the difficulty and importance of it. It was a work of world-wide interest, and whatever we did, and whatever conclusion we came to or opinion we formed would be challenged and criticised and read from one end of the world to the other by every engineer who had any knowledge of such matters at home and abroad.

We were acting, therefore, under a sense of responsibility of whose weight we were fully conscious, not to say of what might ultimately be the danger of this investigation when it came to further developments. Now, we go down and spend three months on the Isthmus and three months in New York investigating the office data, and we make a report. I venture to say that anyone who will read that report will appreciate, at any rate, the very laborious and sincere endeavor to ascertain all we

could about this project and about the conditions, and if you give the engineers of the country a chance to read the report, and with the appendixes and plans which are necessary for its intelligent consideration, I believe we shall find our own confidence in the integrity of our work confirmed by the judgment of every competent engineer in the country. That, of course, we believe, because we did our best.

We are not infallible, and may have made mistakes, but we tried to avoid them, although there were pitfalls at every side. Then, to do this amount of work which we did, and to have it said in the testimony given before this committee by Mr. Miller and Mr. Menocal for the purpose of cheapening it, What did we do? that we wandered around the country looking at parrots and monkeys, that we were enraptured with the novelty of the surroundings; and I find we traveled in the most comfortable manner. We traveled the only route there was. You either go in a steamboat up the San Juan River or you travel on foot, and we did both. This wandering through shady paths, you understand, meant traveling through tropical forests, climbing steep clay hills, and wading swamps up to our necks in water; and there was not a day while we were on the isthmus, except when we were asleep, that we were not engaged mentally and physically in the investigation of this problem, and I feel free to say, and I believe I will be justified in saying, that no matter how that report may be criticised it will prove itself to be a more fruitful source of information and suggestion with regard to this canal project in Nicaragua than is contained in all the canal company's literature put together, and the company, as a company, should be indebted to us for an investigation which has given them more valuable information as to the nature of their own problem than they in all their years of investigation and research have ascertained.

Mr. DOOLITTLE. Do not you think that is rather gratuitous?

Colonel LUDLOW. No; I think not, if you consider our relations as professional men. We are challenged; and I will tell you further what makes me more indignant about this is this fact—that our report, as a report, has not reached the public. They can not get it. This material that has been given here, there is not a newspaper in the country that can not print the whole of it, if they like. These accusations against us come before the public, but our case has not been stated.

Mr. DOOLITTLE. Neither has there been any objection or anything thrown in the way of the publication of your report?

Colonel LUDLOW. Because they can not get it.

Mr. DOOLITTLE. Your report was printed long before the other was?

Colonel LUDLOW. I know that engineers write me for a copy of it, and they say they can not get it from Washington. Of course, necessarily, there is a limited supply of them.

The CHAIRMAN. It is proper to say that only a portion of the report has been in print. It was found to print it all would require several weeks or months, and we were anxious to have the text of the report, and the appendixes and maps are lying away with the expectation of having it published in conjunction with all of these hearings.

Colonel LUDLOW. I do not understand that the committee have any option in the matter.

Mr. DOOLITTLE. Of course, when one is criticising it is easy to criticise——

Mr. WANGER. Would it not be well to have a reprint of that document, No. 279?

Mr. SHERMAN. I tried to make the request, and I stated to Mr. Pick-

ler why I desired to make the request, but he demanded the regular order, and that is the reason why it was not reprinted last week.

Mr. DOOLITTLE. There is no attempt to suppress this information as far as the committee is concerned?

Colonel LUDLOW. Not at all, and I beg you to excuse me from making any reflection upon the committee. I am sure no one would so interpret me. It was only the circumstances of the case in which this volunteer attack proceeds, and the lack of an opportunity of the public to read what we had to say——

Mr. SHERMAN. That is not quite correct, because it was printed; your report was printed, so much as has been printed, and was accessible to the newspapers weeks before this other.

Colonel LUDLOW. Did they get them?

Mr. SHERMAN. I do not know whether they did or not; some did, because I gave it to some of them myself.

Mr. PATTERSON. How was that, Mr. Guthridge?

Mr. GUTHRIDGE (representing Associated Press). Both members of the two associated presses sent out a very fair abstract of the Commission's report. I wrote an abstract of it myself, and I think covered the ground pretty fairly.

Colonel LUDLOW. These engineers want to get it, and they are the ones interested, and have asked for copies. They will get them in the course of time, but it added a little more urgency—perhaps a little more warmth—here to my replies in regard to this matter that we were suddenly and unjustifiedly attacked in a very unfair way with the aid of false and malicious statements.

Now, if you please, Mr. Chairman, I would like to go back a little and review some portions of Mr. Miller's remarks which relate to the engineering, because it will illustrate the difficulty that the board has found almost from the beginning. I refer to that "elusiveness" by reason of which we are unable to get anything fixed or settled. It was all subject to change and modifications, and if objection was made to one thing a substitute was immediately offered, and so on. There are some features of Mr. Miller's statement which I am justified as regarding as having a somewhat serious relation to the affair, and what he has stated, if to be interpreted seriously, would probably have an important influence upon the minds of the committee. I shall endeavor to be as brief as I can. This looseness of assertion I am going to indicate here has not necessarily anything personal about it, but on page 12 Mr. Miller—it is only a small matter—refers to the perpendicularity of the canal banks which we declare we found there.

That leaves things very pleasant in regard to the canal. It may not be an important matter, but as a matter of fact the remarks of the board relate not to the canal banks at all; it was only to some railway cuts we found there. It is a small matter, but it is like a great many others. On page 13 there is the question of locks. Now, the question of locks in this canal is a very important and a very serious matter. No such constructions as are proposed by the company in their project have ever been built of those dimensions, and particularly not of the material which they indicate. They are to be of enormous lifts, double anything that has ever been built before, and they are to be built entirely of concrete, according to the project. There is no estimate in the project for any other material. Now, Mr. Miller quotes us as saying that we admit the locks are all right. Well, we do not, as a matter of fact. We had to construct our own locks and then criticise them. As a matter of fact, the canal company had no locks. There were none on

the ground and they had none on paper. They had no drawings of a canal lock and they had no plans of one.

Mr. DOOLITTLE. Would not that simply be a matter of construction, on Mr. Miller's part, of your report?

Colonel LUDLOW. If you choose; but it is also a matter of misconstruction.

Mr. DOOLITTLE. Of course that would be a difference of opinion.

Colonel LUDLOW. Oh, yes; but what I am saying is that the canal company had locks neither on the isthmus nor in their office when we asked them for drawings of the locks. We saw all they had. They declared they were all they had. We saw a half-finished drawing of a lock which had been laid aside and not later used, and the drawings upon which the estimates were made were little sketches of a few inches large, which were simply used to get the total number of cubic yards in the locks. There were no detail drawings at all. Mr. Miller refers further down, in answer to a question of Mr. Patterson, that the rock through the country was of uniform formation. Well, hardly any kind of rock can be less uniform. It is extremely uncertain; you drop a boring in there and a boring in here and you meet with surprising changes of material. You find rock where you did not expect to find rock, but clay, and clay where you expected to find rock. It is a volcanic country which has been upheaved and turned up and turned over, and shaken——

Mr. SHERMAN. You did not make any borings?

Colonel LUDLOW. No; we did not undertake to make borings.

Mr. SHERMAN. I am simply asking the fact.

Colonel LUDLOW. No; we made none at all.

Mr. PATTERSON. The opinion you express is from the borings they made?

Colonel LUDLOW. Assuredly; we had all their data, and that is where we got most of the information, as a matter of course, of everything out of sight. We spent three months investigating those data in New York, and the company offered it freely to us.

Mr. DOOLITTLE. He stated that the formation is absolutely of igneous rock, did he not?

Colonel LUDLOW. There is a tremendous diversity of material.

Mr. DOOLITTLE. But it comes under the general head of igneous volcanic rock?

Colonel LUDLOW. Yes.

Mr. DOOLITTLE. In that way it is of the same general character of rock?

Colonel LUDLOW. Not in the least. You can not say that a rock you could not cut with a chisel and a rock you can crush with your hands are of the same character.

Mr. DOOLITTLE. But it is all volcanic rock?

Colonel LUDLOW. Yes.

Mr. DOOLITTLE. To that extent, then, I say that it is uniform?

Colonel LUDLOW. Yes, but not from an engineering standpoint; it is distinctly anything else.

Mr. STEWART. Mr. Miller simply said the rock was of the same formation in reference to sliding and disintegrating?

Colonel LUDLOW. That can not be stated as an engineering proposition.

Mr. STEWART. Mr. Patterson asked:

Did you find the same material in your borings?

And the answer is:

Yes, sir; there is no tendency of the rock to slide or disintegrate.

Colonel LUDLOW. Which is a distinct error. Portions of that rock left on the surface in a rainfall went to mud. There is a lot of that material there.

Mr. DOOLITTLE. It would not be rock, then?

Colonel LUDLOW. It is what the company called rock. There is rock that when you expose it to the air and rainfall disintegrates and goes to pieces and becomes mud. It only shows the necessity for the most careful investigation of that material. Now on page 14 Mr. Miller, on the top of the page, indicates the results of the borings at the Ochoa Dam—wait a moment, if you please. Here is a very interesting item at the top of the page. Mr. Miller, in answer to the question of Mr. Patterson about the San Juan River, says:

The San Juan River is a large navigable stream; is from 40 to 100 feet deep; it is 500 to 1,500 feet wide.

If that were true, without qualification or some knowledge otherwise, the question would be asked at once that if we have a river 40 to 100 feet deep why should you go to work and build a canal to get up to Lake Nicaragua. Of course the river is not 40 to 100 feet deep. There is a portion where it has that depth, and that is mainly at one place, where they have a stretch of about 18 or 20 miles, and that is above Ochoa Dam. Generally the channel only allows the navigation of light-draft steamboats, but there are 27 miles at a stretch where you have to dredge to get a ship channel at all.

Mr. DOOLITTLE. The whole 27 miles?

Colonel LUDLOW. The whole upper 27 miles of the San Juan River has to be dredged.

Mr. DOOLITTLE. How deep on the average?

Colonel LUDLOW. That is hard to say. The San Juan River is 10 feet deep where it leaves the lake. There are bars in the river of 4 and 5 feet deep, and then a portion 10 or 15 feet as you come up.

Mr. DOOLITTLE. You mean there is 25 miles of actual dredging and clearing out of the channel to be done?

Colonel LUDLOW. Twenty-seven miles.

Mr. DOOLITTLE. Without a break?

Colonel LUDLOW. Without a break, and the profile shows it. There might be little deeper pools, but practically you have to dredge and blast over that whole distance, and the company's estimate shows that is to be done on their profile. Now, just below, on page 14, is reference to the foundations of Ochoa Dam; Mr. Miller says it is found at the site of the Ochoa Dam there was no rock bottom:

As a result of that it became necessary to find some other way to build the dam and rest it upon clay bottom so as to make it permanent and safe.

There he seems to consider a clay bottom a good thing to get, but the chief engineer's statement says that the foundation of the Ochoa Dam—not the statement here but his technical Chicago paper states—that underlying the site of the Ochoa Dam the material is "gravel, clay, and rock, in the order named," and the only drawing they had to show us was a cross section of the river at that point, as the proposed construction of the Ochoa Dam. The tracing delineated the river with the sand and gravel and clay bottom, and underneath it was depicted a very handsome ledge of rock underlying the whole width of the river and curving nicely up on each bank. Well, it looked from the information and from that cross section like a beautiful place to build the dam.

Unfortunately the borings disclosed the fact that there was no rock or clay there within 23 feet. It is possible if they had gone 25 feet they may have found it, but they went down 23 or 24 feet and the pipe choked and they gave it up. That is one of the points we insisted upon, because if you can find rock at 20, 30, or 40, or even 50 feet, it would be an extremely valuable thing. On the next page, however, in the afternoon's testimony, Mr. Miller states that the Ochoa Dam "of course is to be built on a sand bottom." There is no reference to anything better than sand, and he says:

The question as to whether that is sufficient or not is not a question of theory, but settled by any quantity of great public works all over the world.

He says below:

It is not necessary to repeat illustrations regarding the fact that any superstructure of any weight to-day can be built resting entirely upon sand.

And evinces the tendency to take an enthusiastic view about sand as a foundation. Sand is not regarded as a desirable foundation for a dam under water if you can get rock or even hard clay, and an engineer would try a long while before he would accept the idea that he would have to build on sand.

Mr. PATTERSON. What do you think of the practicability of building a dam on a sand bottom?

Colonel LUDLOW. That we discussed at great length in our report. We studied that problem—just sweated blood over it. We worked on that thing for weeks, because there was nothing else for us to do. We could not assume things. You can engineer to any extent if you assume your data, and it is a great comfort to be able to do it; but, unfortunately, with our responsibility we could not. We had to take what we had, and we had to take sand, and had to draw a plan and try to build a dam in sand with a clay bank, on a river that would rise maybe 20 feet on you, with a big stream 1,000 feet wide.

Mr. STEWART. But you came to the conclusion it could be done?

Colonel LUDLOW. We did, but not the way the company proposes to do it. We are pleased to find that the chief engineer concurs with us in this, and he has gone even better. He had a dam 500 feet base; it is now 1,000 feet base. Measuring up and down stream we laid out about 900 feet. We doubled the thing, and he has recently come up approximately to our figures of the cost. I did not know that change had been made. I notice that in concluding the testimony he does not make any change in the total cost of the canal. The estimate remains about the same. Now, Mr. Doolittle (you will not mind my mentioning you), you asked the question about the width of the lake and the river channel, and Mr. Miller says that the Commission recommended——

Mr. PATTERSON. What page is that?

Colonel LUDLOW. Page 16. Mr. Miller refers to the width of the Manchester Canal, the Kiel Canal, the Suez Canal, etc., and says the Commission recommended that the width of the channel of the river should be increased to 250 feet, and he says for what reason he did not know. No one would suppose that we had given two or three pages of reasons in our report, which we are willing to submit to the engineers of the world as being absolutely sound and good reasons—substantial reasons. That is another evidence of the tendency to confuse things. He is now talking about the open river with a current—a river 1,000 feet wide.

Mr. DOOLITTLE. What would be the current after building the *Ochoa Dam*?

Colonel LUDLOW. I do not know——

Mr. DOOLITTLE. Have you made any estimates?

Colonel LUDLOW. It would be very difficult. No; we have not, except in a general way, and what current there may be is a matter to be considered. It might be as much as 2 or 3 miles an hour. Whether it would be 4 or only 2 I do not know.

Mr. DOOLITTLE. You know it would be more than half a mile an hour?

Colonel LUDLOW. If you knew how high that lake would rise——

Mr. DOOLITTLE. At 110 feet, I mean.

Colonel LUDLOW. How much higher will it go?

Mr. DOOLITTLE. I am not asking that; that is not the question. I say will the current be more than half a mile there with the lake at 110 feet?

Colonel LUDLOW. There may be no current whatever, because with a level of 110 feet it may be level all the way from the lake to the dam.

Mr. DOOLITTLE. Have you ever estimated to see what the current may be?

Colonel LUDLOW. We measured the flow of the river.

Mr. DOOLITTLE. I mean with that elevation?

Colonel LUDLOW. We made a great many estimates.

Mr. DOOLITTLE. Do you know whether or not you made that estimate?

Colonel LUDLOW. I do not know at the moment. We had no way of determining it. We could only make a sort of intelligent guess at it because we did not have the data to determine it. It would certainly have some current while that lake is varying. The lake is going to discharge itself, or else drown out the whole basin. You have to let the water come out during the rainy season.

Now, there is a confusion between this river channel and the canal. The two things are not synonymous, and in consequence we do not call the deepening of the channel in the river the canal, and that portion is not comparable with the Manchester or the Suez, which are inclosed between banks. It would not be seriously considered practical to make a 125-foot channel in the river simply because the Manchester Canal has 120 of width. Now, then, about this matter of the lake channel, we were in favor of increasing that, and that is not regarded by them as judicious. The company thinks 150 feet is enough, and sometimes the lake channel is called a part of the canal. It is nothing in the world but a trench made in the open lake. It is not a canal. It is only like deepening the channel of a harbor, of which we have dozens of examples all over the country. The one we took as being the nearest is Mobile, for the reason that Mobile channel is of considerable length, and the materials which had to be dredged from Mobile Bay were almost exactly similar to those we found on the bottom of Lake Nicaragua.

The board took the trouble while we were being delayed, if you please, at the mouth of the river to go out in the lake and sound and measure the depth of the mud by thrusting a long pole into it and measuring it carefully. Nobody had done it before, and we wanted to know, and we found out there were 9 or 10 feet of soft mud. First it was about as thick as pea soup to start with. Then it gradually thickened until you got down to material through which you could not with the weight of your body thrust a pole. The material was almost exactly what was found in Mobile Bay. We asked the officer in charge of that work to tell us what kind of a side slope they would require with such material. He gave us his opinion, which was an extremely interesting

and valuable one, that the slope of such material at Mobile ran something about 15 or 20 to 1. The company's lake channel has a side slope of 3 to 1, which would be a proper slope, perhaps, for reasonably soft material out of the water instead of under the water.

Even firm material would not stand at such a slope as that under water, and so we had to increase the slope. We had to increase the width, too, because this is a channel in the open lake, 14 miles straight away in the open lake. Another point I object to is Mr. Miller's assertion that the only object we had in increasing the dimensions of that channel was to increase the cost of the work. That is absolutely untrue and a perfectly gratuitous statement, and our own report refutes it. We give the reasons for doing that in our report, and anybody can read it, and there is no excuse for making a statement of that kind. The inference all through both his testimony and that of Mr. Menocal is that we are simply trying to increase the cost on the theory that having an unlimited treasury it did not make any difference, and while they were trying to be economical we were trying to be reckless and as extravagant as possible. The next note is on page 20, and is rather an important matter. It is perhaps worth while to look into it. It is about two-thirds of the way down the page, where Mr. Treat is referred to. He was the gentleman who built the railroad for the company at Greytown, and did it very well, and was in Nicaragua for quite a length of time. Mr. Miller says:

> He wrote me a letter sometime ago, stating that he would take the entire contract for the canal and do all the work at the price named by our chief engineer in his estimate, we, of course, guaranteeing the quantities to be not greater than those stated in their estimates. Further than that, he offered to build the entire canal for $90,000,000 and take no guaranty as to the actual quantities.

The board, of course, was interested in this proposition of Mr. Treat, and it is an important matter. He is a responsible person and a man of repute and of resources, and we wanted to hear what Mr. Treat had really proposed to do for the company, and he was good enough to come and see us at the office, and we asked about this proposition. This was last summer. It is quite possible there may have been some change in the matter since then. He may have made a further proposition to Mr. Miller, but I do not believe he has, for last summer, while investigating this proposition, Mr. Treat was good enough to let us have a copy of his letter, and he said he had no objection to letting us see what he offered to do.

Mr. Miller's statement is somewhat surprising unless it can be modified by some subsequent proffer on Mr. Treat's part, for the reason that Mr. Treat's proposition related exclusively and solely to the western division, which is the easiest and nicest pieces of work on the whole route. He made no proposition for the construction of the eastern division, and told the board he would not have anything to do with it. Now, unless he has changed his mind since then, this statement of Mr. Miller's is entirely in error, and entirely misleading to the committee, and to anybody who takes account of it.

Mr. DOOLITTLE. You say Mr. Treat never offered to construct the entire work?

Colonel LUDLOW. He told us he refused to have anything to do with the eastern division. He showed to us and explained to us what he offered to do, and left us a copy of his letter. If the committee is curious about it, and Mr. Treat is willing, I am perfectly willing to furnish the committee with a copy of the document which Mr. Treat gave us last summer as being the last proposition he had made to Mr. Miller.

We have that in our possession. There is no secret about it. Now, why should it be so travestied here? He made a proposition to build the western division at the engineer's prices, but with certain conditions. One of the conditions was that they should build a million dollar's worth of railroad to start with.

Mr. PATTERSON. What did he agree to do it for?

Colonel LUDLOW. He agreed to do it at the engineer's prices—at Mr. Menocal's prices—provided they did certain things. One was that they should furnish him with a million dollar's worth of double-track railroad, standard gauge, on the western side.

Mr. STEWART. What is the date of the letter?

Colonel LUDLOW. I can get a copy of it if you like, but I have not it with me. I have not it even in my possession.

Mr. DOOLITTLE. You mean the western division from——

Colonel LUDLOW. I mean the Pacific division; and he told us specifically he would not have anything to do with the eastern division. He has been there; he built the railroad from Greytown to the hills. Recollect these are 1890 prices; those are the prices contained in the pamphlet of the chief engineer's report on final location of the canal. Furthermore there were other conditions attached besides the construction of forty miles of railroad. That means about twenty miles of double-track railroad, at a cost of about $25,000 a mile for each track. There are other conditions attached, and one was that he offered to build the La Flor Dam. He offered to build it providing the company would guarantee he would not have less than 2,000,000 cubic yards to put into it, and provided, further, whether clay, stone, or earth went into it it should all be charged up at rock prices. He made some other stipulations there, but it is not material and it only shows the nature of his proposition, and that this rendering of it is absolutely misleading.

Mr. DOOLITTLE. At what amount did he agree to build the western division?

Colonel LUDLOW. As I say at the company's prices, I do not know what the total was.

Mr. DOOLITTLE. Was this railroad at a cost of a million dollars to be built outside of that?

Colonel LUDLOW. It was to be furnished by the company, and they were also to furnish certain other things—if I remember, some dumping ground or grounds, and grounds for his hospital and barracks, or something of that kind, which he would not be at the expense of getting from the Government. They were to furnish a lot of things, in consideration for which he would do thus and so. It was a qualified proposition all the way through, and that is the case to-day unless Mr. Miller has received a further proposition from Mr. Treat. Now, there is a little more on the top of the next page, page 21, where Mr. Miller says:

> A greater portion of this entire canal, so far as vessels are concerned, is without bottom. The river, except at points I have mentioned, is anywhere from 40 to 100 feet deep, and after you get out in the lake over the mud I have described then the lake is from 50 to 150 feet in depth, and so on.

As a matter of fact, when you take out the deep portion of the San Juan and a portion of the lake you still have only half of your canal route instead of having a greater part of it. On page 22 Mr. Miller says we only stayed twelve or fourteen days on or near the line of the canal, and never made any surveys of any kind. Of course, it is the same old thing. He says we refused to stop at the site of the Ochoa Dam, and of course never made any survey there. There seems a disposition all the time to misstate things and confuse language. I do not know what

Mr. Miller means by a survey, but I find the same confusion in Mr. Menocal's testimony that we did not survey this or that.

Apparently surveying means doing something with an instrument, which may be that when a man is running a transit or level he is surveying; that he can not survey a country otherwise; and there is a confusion between engineering and surveying, as though the two words were synonymous, and when you are surveying you are doing engineering. As a matter of fact, surveying is only preliminary to the engineering and the basis of it. You employ people to do that. You pay transitmen and levelmen and expect them to do their work. The engineer does not do that himself. He is the man who considers the results and applies them to the project, and estimates. A great deal of stress is laid upon the immense amount of surveying done down there; 4,000 miles of transit line run and so many miles of levels. Well, 40,000 miles of transit line would not build the Ochoa Dam, and you can not construct a 40-foot lock with a spirit level. Engineering is something more than running over the country with a transit and level. Now, we are reproached with not having made that kind of surveys.

Mr. STEWART. It is absolutely necessary, however, to have correct surveys?

Colonel LUDLOW. Certainly; but you can't do without engineering.

Mr. STEWART. Did you have it done?

Colonel LUDLOW. We had no time for that.

Mr. STEWART. And they claim you did not have the time?

Colonel LUDLOW. I would like to know what amount of work we would have done if we had undertaken to run transit and level lines.

Mr. STEWART. I understand you are criticising some portion of Mr. Miller's statement as incorrect, and now you admit it is absolutely correct?

Colonel LUDLOW. I do not admit anything of the kind. We made very important surveys.

Mr. STEWART. Done by you?

Colonel LUDLOW. We made very important surveys. We made the most important surveys made on that route.

Mr. STEWART. But there were some necessary surveys that you did not make.

Colonel LUDLOW. Oh, certainly; there are 70 miles of river to start with.

Mr. STEWART. And you would have made them if you had had the necessary time, and you consider those necessary?

Colonel LUDLOW. We regard them as absolutely essential, but these gentlemen say we made no surveys. Well, we did.

Mr. WANGER. Did I understand you on yesterday to say that the exact length of the San Juan River had not been determined?

Colonel LUDLOW. It has been determined. It was determined originally by Childs in 1852, and Childs was quite accurate in his work. There was a preliminary reconnoissance confirming Childs, made by the Lull survey in 1872, and they quite agree. As it happened, the canal company have thrown off 4 miles of that length by inadvertence, or otherwise. The length of the river as stated in the canal company's project is 4 miles less than that. We call attention to that in our report. It is some error which has crept in, and we simply wanted to correct it. We do not know where that 4 miles is. It may be in some place where it may require a good deal of work, but it did not matter in that distance, because we have used the Lull survey as the basis of the estimate.

Mr. DOOLITTLE. It might be somewhere where it would require a great deal of work, and the company left it out intentionally to deceive somebody?

Colonel LUDLOW. I do not think that; I think it came in by inadvertence. You will find that stated in our report. Since you asked about the length of the river, I answered your question. It is about 69 miles, in round number, from the lake to the Ochoa Dam, and 120 miles, if I remember it, all the way to the sea.

Mr. DOOLITTLE. You would deem them quite capable in that they left it out purposely to deceive somebody, according to the statement you made yesterday relative to the foundations of the locks?

The CHAIRMAN. I submit that that is not a proper line of interrogatory.

Colonel LUDLOW. It is unprofessional.

The CHAIRMAN. That is not a matter the committee are interested in at all.

Mr. DOOLITTLE. I am interested in it at least, Mr. Chairman, as a member of the committee.

The CHAIRMAN. I do not think that is fair to the witness or a proper line of interrogatory. If the committee declares its sense, it shall be——

Mr. DOOLITTLE. I do not care to put the committee to any such trouble at all.

Colonel LUDLOW. Well, further along on page 22—I do not care to stop over this too much—Mr. Patterson inquired whether Mr. Miller did not think any competent engineer could sit in Washington, and with the data which our board had have as good an opportunity to arrive at a correct conclusion as we had, and Mr. Miller said "certainly he could." In other words, Mr. Miller seems to think our visit to the Isthmus was practically fruitless, and we might have saved the time and expense of traveling and stayed in New York or Washington and made our report there. We can not agree with him. We got important data and we made important surveys. We surveyed Greytown Harbor, and made the most complete survey of it that has been made. We had the advantage of the officers of the *Montgomery*, who did the hydrographic part, while we did the shore part.

They did the offshore work while we did the shore work. We surveyed the west shore of Lake Nicaragua, and wherever we crossed a stream and had an opportunity of measuring and getting an idea of the quantity and the height of the floods, etc., we got it, and so we have been able to correct the hydraulic data in a very marked measure. We regarded that as a very valuable result obtained by our visit. We also had an experience of the heat and other conditions that affect labor there, and that is an important matter. There was not much we could do we had but three months and we wanted to go to Costa Rica and Panama and we had to make the best use of our judgment, and we did that. We only had six months' time to do the whole thing in. The law was absolute on that point in that the report had to be in the hands of the President on or before the 1st day of November. The Secretary of State called our attention to that fact, and the whole appropriation was only $20,000, of which an allotment of something less than $15,000 was for the salaries of the board, $5,000 to each, less whatever they might be receiving from the Government as salaries.

So you can see we were extremely restricted. We had to take everything from New York, which was an expensive affair, because we could not get what we wanted on the Isthmus. We went on and finished the work to the best of our ability, employing all the time and all the

money, and when we found our appropriation was about run out, or certain to be exhausted, we held a council of war and determined to go on anyway, and did go on to the extent of having expended some $5,000 or $6,000 of our own money in order to complete our investigation and make our report as satisfactory as we could.

Mr. STEWART. You are getting a further appropriation this year in an appropriation bill in this Congress?

Colonel LUDLOW. I do not know, sir.

Mr. STEWART. Will not that be reimbursed to you?

Colonel LUDLOW. I do not know about that. I submitted the matter to the Secretary of State, and he was good enough to say he would have it included in some estimate.

Mr. STEWART. I think it is in one of the estimates and in one of the appropriation bills.

Colonel LUDLOW. How the matter stands I really do not know. I might perhaps have omitted any reference to it, but since the work we did was challenged I wanted the committee to understand we did the best we could, and perhaps a little more. We spared nothing, either ourselves or our resources. Mr. Patterson asked if we could not have stayed in Washington just as well. Mr. Miller wisely put at the bottom:

Starting upon the premises as to what we have given him is true.

He meant, of course, all the facts were correctly gathered together. It seems the Bogart board sat in New York, and got into serious trouble because the borings given them to examine and to go by were not correct. They stated that the locks were to be founded on rock, and this was a very serious error. It would be interesting to know who supplied the board with those rock borings.

Now, the matter in regard to Mr. Donaldson has been sufficiently stated. He is quoted, on page 24, by Mr. Miller, with coming within $1,000,000 of Mr. Menocal's estimate, and on page 11 his estimate is stated as less than $100,000,000.

On page 24 Mr. Miller states:

Everyone knows you can go along the river and tell what the high-water mark is. The rise of the San Juan River is from 4 to 6 feet.

Now, it is incredible Mr. Miller should have made that statement seriously as a physical fact of the San Juan River. He never could have made it if he had taken the trouble to look at his own water-marks. He says anybody could. We did, and looked at them with a great deal of interest and carefully investigated among the natives as to what the marks were, and now the committee is supposed to believe that the rise of the San Juan River is from 4 to 6 feet. We know it is 14, 15, 16, and 20 feet, as we actually measured it.

Mr. DOOLITTLE. At what point would it reach that height?

Colonel LUDLOW. The highest point is at the Machuca Rapids, about 18 miles above the site of the Ochoa Dam, where we were able to get a satisfactory determination of where the water reached. We treat of that in our report.

Mr. DOOLITTLE. Now, at a point as low as Ochoa would the water be up at that height at the same time it was at the height you speak of at that point?

Colonel LUDLOW. That would depend. Those are things difficult to answer. The San Juan River, while it does rise and fall through a wide range, is in no sense as violent a river as the San Carlos, which comes in above the Ochoa Dam. It might be a sudden flood came down

the San Carlos and the water be higher at the dam than farther up the river. That has actually happened. A current upstream has been actually observed, owing to the San Carlos coming down with a great flood and temporarily got rid of it by going upstream and downstream both.

Mr. DOOLITTLE. You do not mean for the committee to understand there is a rise along the whole length of the river of 14 to 15 feet?

Colonel LUDLOW. Only at points where you can measure it, of course. We found plenty of them. We found one near Ochoa of 15 feet.

Mr. SHERMAN. Right at that point Senator Miller says the river has never done serious damage to the country. Do you claim that is an incorrect statement?

Colonel LUDLOW. I do not know anything about it, and nobody knows. It is a wilderness. There are only a few haciendas and plantations along the banks of the river, the population is extremely limited, and buildings are very few. All that Atlantic side is almost without population. The San Juan River in the upper section as far as the Ochoa Dam has quite high banks and shores. When you get below this you get into the delta, and then it is all a vast swamp and wilderness.

Mr. DOOLITTLE. What was the occasion of the rise of the river particularly at the point where you discovered these banks marked this rise?

Colonel LUDLOW. There might be two reasons. There might be a meeting of two floods, one out of the San Carlos upstream, and one out of the San Juan downstream.

Mr. DOOLITTLE. Do the banks approach each other more closely?

Colonel LUDLOW. The banks come in, and there is a rocky bottom, but the bed of the San Juan above where the San Carlos comes in is fairly stable. It has a great big, wide valley, 900 or 1,000 feet wide, 500 feet in some places and 1,500 feet in some other places. It is a fine stream. Now, on the next page, 25, perhaps it is not worth while to go into these details, but Mr. Miller makes some statements in regard to earthquakes. I do not know whether it is worth while to state it or not. He says that the motion of an earthquake at the surface of the earth is very slight. I suppose people who live in earthquake countries would be very glad to be sure of that, and that really to enjoy an earthquake you have to go to the top of a church spire, so as to get 100 or 200 feet above the ground. Our board got very valuable information about earthquakes and volcanoes, which was a vital question, and we investigated it as far as we could, and one of the appendixes to our report is a paper by Professor Pittier, of Costa Rica, who is a perfectly competent man, and a scientific man, and he, at our request, prepared some notes and data on that subject which are extremely interesting and valuable, and very reassuring, if you like.

It is largely upon information derived from him that the board felt satisfied that the work could proceed without regard to the contingencies of earthquakes. At the top of page 26 Mr. Patterson inquired about the harbor at Brito, in regard to the difficulties there—I beg pardon. There is one other matter I want to suggest. At the bottom of page 25 Mr. Miller recurs to the question of locks, and suggests if anybody apprehends there is any danger of the locks from earthquakes they can be built of steel. It only shows the willingness to change the proposition and modify it by something else to meet objection, which is a perfectly rational thing to do, but it also shows the elusiveness of the project as a project, that you can not pin anything down. Now, in

regard to the harbor at Brito, Mr. Patterson wanted to know about the importance of the work. Mr. Menocal says in his travesty of our doings there we ran from Rivas to Brito on the Pacific coast, and looked around a little and took a bath, and then went back to camp. That is all we did, apparently.

Now, as a matter of fact we spent the greater part of the day there and made observations which satisfied us in regard to the physics of the place and other matters which we afterwards found extraordinarily valuable in considering the construction of the harbor there. We observed two things right off. One was that there was a strong breeze blowing offshore that confirmed the statement that the trade winds blew entirely across the isthmus and out to sea on the Pacific side. It was a fresh breeze and we were on the top of a hill and we had to hold on a bit. Furthermore, we observed that while the water was entirely calm there was a surf breaking on the beach not less than 5 or 6 feet in height. Even with the calm weather the surf was breaking on that shore. Those are the things an engineer wants to get. He does not note them with the transit or level, but he notes them with his mind.

We noted other things. We noted that the site of the last rock on that side was in a place where we did not believe there was any solid foundation whatever. It looked like a very dangerous place, although the books we had to go by, the official report of the canal company, estimates for rock to be removed at the site of that lock. Now, it was difficult for us to believe there was really any serious quantity of rock at that point, and of course we made a note of the fact and later investigated it. We found that the estimate of 1890 was completely in error as to there being any rock there.

Mr. DOOLITTLE. Is it not in exact conformity with the estimates to remove material where the material was not absolutely known to estimate upon the basis as given for the removal of rock?

Colonel LUDLOW. No; really, as a matter of fact that is not quite true.

Mr. DOOLITTLE. Is not that about true?

Colonel LUDLOW. No; not about the truth. The fact is, there was a boring made at the site of that lock, and this estimate was made in 1890, and we got the original memorandum of it. We got the notebook of Mr. Hunt or some one of the company's engineers, and we examined it to see. There was but one boring made at that time, and the engineer reported that his auger—that is all he had; he was not boring with a drill, but he was boring with an earth auger which would not go through a chip, but would go through soft material—he reported something hard down there, whether rock or something else. Now, that is absolutely all the information on which that Lock No. 6 is estimated for as almost the exact quantity of rock to be taken out of that site.

Mr. DOOLITTLE. At what depth did they go there; do you recollect?

Colonel LUDLOW. They struck this thing, I forget, 20 feet or something; it may have been a submerged log in the mud that fetched the auger up. You will find in the official report of the chief engineer for 1890—the official report—that at lock No. 6 there is to be removed not less than 61,698 cubic yards of rock.

Mr. DOOLITTLE. Now, is not that estimated for in the estimates of the company as rockwork, and does not it embrace a portion of the cost in accordance with the company's estimates?

Colonel LUDLOW. How is that arrived at?

Mr. DOOLITTLE. I asked you if that is not true?

Colonel LUDLOW. I do not believe it is absolutely true; I do not really believe that indication is sufficient.

Mr. DOOLITTLE. I say to remove that rock of course would add to the expense of construction.

Colonel LUDLOW. I beg your pardon. I do not agree with you. The fact is that rock would have cheapened the construction.

Mr. DOOLITTLE. It might——

Colonel LUDLOW. I am sure it would, as I will tell you later if you wish to know.

Mr. DOOLITTLE. It is more expensive to remove rock than earth.

Colonel LUDLOW. But there are other things to be taken into account. When you want to build a lock you would like to have a rock bottom to build on. A lock is a very dangerous construction, and you get the best foundation you can, and rock is very desirable, even if it costs more; but as a matter of fact you will find, if you will look at the revised estimates of the company in 1895, made at our instance last summer after a further investigation of that site, the borings disclosed the unwelcome fact there was no bottom to it. It was soft mud as far as the borings went. They could not even find a hard place. The result was the company added $250,000 to the cost of that lock for putting in a foundation. The removal of the rock had been estimated for at a cost of $77,000, and by the fact there was no rock there the cost was put at $250,000.

Mr. DOOLITTLE. Is it any more important in a matter of this sort to have a natural rock foundation than that any of these great dry docks being constructed by the Government should have a natural rock foundation?

Colonel LUDLOW. Well, there is no necessity——

Mr. DOOLITTLE. I say there is no greater need of a rock foundation in a lock than in a dry dock?

Colonel LUDLOW. It is very desirable to have it.

Mr. DOOLITTLE. But I say it is not more necessary; one is as much important as the other, is it not?

Colonel LUDLOW. In some senses I should say it is, but I am not really as familiar with the construction of dry docks as I think my colleague in the Navy is.

Mr. PATTERSON. Your judgment is, it is entirely practicable to build a lock in that soil, but it would be cheaper and better to build it by excavating rock?

Colonel LUDLOW. If you can find a rock bottom for it I think you have got as good a piece of bottom as you can find. The next best to that, perhaps, would be a tough, hard clay, and sand would be a very dangerous thing to work in for a small structure of that kind, comparatively—I mean small in relation to its enormous weight. You would rather not get sand unless you would be sure you can keep it confined; you certainly do not want mud. You would look for some other place, that is all.

Mr. PATTERSON. And disconnected rock would be expensive, too?

Colonel LUDLOW. You would not want that. A mixture of bowlders and sand and clay makes a very poor bottom. You want something coherent and uniform, if you can get it. You do not want to build one corner of the superstructure on rock and have the other corner resting on something that would give way, but you want a uniform bottom, so that you could have the whole uniform, even if you have poor material, and have it uniform, so the settlement and weight would be equally distributed. I believe that is all of Mr. Miller's testimony I care to note.

The CHAIRMAN. Does that conclude that branch of the subject?

Colonel LUDLOW. For the moment. I was going to Mr. Menocal's statement, which was unfinished on yesterday.

The CHAIRMAN. I only want to suggest after you were through with your statement I wanted to ask a few questions.

Colonel LUDLOW. I am entirely at the disposal of the committee for any length of time. Since the committee has called for me, and since we have embarked upon this matter in consequence of the attack made on the Commission, I am quite willing to see the thing right through, although I am in no sense prepared for it.

On page 51, Mr. Menocal states the following:

I have made observations as to the rainfall and discharge of the streams and other meteorological conditions.

That is partly true, and in reply to a question from the chairman—

Your observations have enabled you to understand every class of phenomena affecting the canal?

The answer to that is—

Entirely.

He says:

I do not know that I have a knowledge of what is termed the regimen of the rivers, but I have the maximum and minimum of the rainfall and the floods for a number of years.

Now, I do not understand that statement. Nobody knows the maximum flood or minimum flood; no observations have ever been made. The maximum flow of the San Juan has never been measured or noted, to anybody's knowledge, and as far as the rainfall is concerned, we found the company's observations were extraordinarily incomplete, considering the seriousness of that item down there. They had a three years' record at Greytown, which was all very well and good. If they had a three years' record of the San Francisco Basin, it also would have been valuable where these great clay dams have to be built under the rainfall, and the Board found reason to believe the rainfall in the San Francisco Basin might be at times, and even for long periods, as heavy as it was at Greytown. Over on the western division, where the rainfall is much less annually than on the eastern division, we ourselves experienced a tremendous downfall, which, according to Dr. Flint, who was the observer at Rivas for that region, was a 3-inch rainfall. I mean 3 inches in an hour. We thought it might be.

Mr. STEWART. In answer to the chairman:

Have those observations been preserved?

He answers:

Yes, sir; they have during the time I was there. They have not been peeserved for an uninterrupted series of years, as they should have been, because we have not remained in the country permanently; but during the time I was there I made observations regularly.

Colonel LUDLOW. Everything needs explanation. During the time the company was there they did not observe the maximum and minimum floods.

Mr. SHERMAN. But Mr. Menocal says he did?

Colonel LUDLOW. That is the trouble.

Mr. SHERMAN. Do you mean to say he did not?

Colonel LUDLOW. They have not the records. He may have observed it, although he qualifies himself in saying so. It may be true he did observe it, but if he did he made no notes of it.

Mr. SHERMAN. That you have seen. He may have noted that, but you do not mean to say he has not noted that?

Colonel LUDLOW. Would he have kept that from us when we were investigating this thing last summer, and when we were in communication with the canal office every day, writing letters, etc.?

Mr. DOOLITTLE. Did you ask for this specifically?

Colonel LUDLOW. For what?

Mr. DOOLITTLE. In regard to the rainfalls.

Colonel LUDLOW. We asked for everything they had.

Mr. DOOLITTLE. But did you ask for this specifically?

Colonel LUDLOW. I am not trying to get away from you, I am going to tell you all I know about it. The correspondence speaks for itself. We did ask, as a matter of fact, for all rainfall observations, and got them as far as we could, and we recorded them as a part of the report. We asked for all river gaugings, and we got those and recorded them, and they are a part of our report. That is specific in both cases.

Mr. DOOLITTLE. I want to ask you a question right there. Was Mr. Menocal at the company's headquarters during all the time you were doing your work in New York, or was he with you?

Colonel LUDLOW. Oh, no; he was sometimes with us. As I understand, he was not regularly in the company's office, but he was frequently in there, as I understand, and it was close by ours. Mr. Menocal had his own duties over in Brooklyn. We started to have conferences together. We found it took up unnecessary time for him to come from Brooklyn to New York and back again, and took him away from his work, and we found afterwards it was more convenient to make the inquiries we wanted to get from him by correspondence. The canal company placed everything at our disposal, and they almost placed entirely at our disposal Mr. Bennett, who was one of the engineers and draftsmen, and who came to and fro in and out of the office. If we wanted anything we sent in to Mr. Bennett and he would send it over or see Mr. Atkins, the secretary, who would of course instruct Mr. Bennett.

Mr. DOOLITTLE. This request was not made of Mr. Menocal himself?

Colonel LUDLOW. Of Mr. Menocal himself, personally?

Mr. DOOLITTLE. Yes.

Colonel LUDLOW. Well, the record would show. We have copies of all the letters we sent. It may have been addressed to Mr. Menocal. Sometimes the letters would be sent to Mr. Menocal at the company's office, and it might be answered from there, possibly, if it was a routine affair, without being referred to him.

Mr. PATTERSON. It perhaps did not occur to you if he made the observations they would be found elsewhere than in the company's record?

Colonel LUDLOW. We could not expect to look for them elsewhere. There is where they ought to have been because they were so extremely important.

Mr. STEWART. You note he states these observations have been observed by him?

Colonel LUDLOW. And that the observations made were noted, but I assure you that these things are carefully recorded as well as we know how.

Mr. STEWART. He says he made these observations, and that these observations have been preserved. He states that on page 51.

Colonel LUDLOW. What do you infer from that?

Mr. STEWART. I infer you contradict that statement.

Colonel LUDLOW. Now, what do you infer from that; do you mean as a matter of fact he has furnished observations to someone showing the maximum and minimum floods?

Mr. STEWART. That is my understanding.

Colonel LUDLOW. The canal company, as a company, knows nothing about it, nor any member of it. If Mr. Menocal has these observations it is not of knowledge in the company's office, for they gave us everything they had freely and fully.

Mr. STEWART. Did you specifically ask for this data?

Colonel LUDLOW. Surely; and recorded what they gave us. We were trying to get the plane of the rivers, which would have been very valuable to us if we could have found what the height of the water surface was at that time. There is no such record. On the top of the next page (52) he says:

The largest flood which has occurred in the San Juan River was 42,000 cubic feet per second.

That explains that other statement of the maximum and minimum flood being noted and preserved. That datum relates to the only time the company ever gauged the San Juan River, and that is when they got the 42,000 feet, or approximately, and we got a record of that. That was important. Then after we got the record we were unable to determine from all the statistics we could get what the height of the river was at the time the observation was made, but from the quantity given it is perfectly evident that the river was not very much more than the moderate fall stage. There is no question about any flood, because the water marks were so much higher. I now look at a paper formally prepared by the chief engineer as a contribution to the World's Columbian Water Congress in Chicago in 1893. This was prepared by the chief engineer, and contains a great deal more engineering information than all the company's official reports, and we have had frequent occasion to go over that and the other, or both, as they are both official. This is more particularly, however, addressed to the engineering fraternity of the world. Now, on page 19 of that a statement is made which relates to the only gauging the company made:

The flow of the San Juan at Ochoa at high flood in both the San Carlos and San Juan has been found by careful gauging to be 42,000 cubic feet.

Now, that agrees with this statement here of 42,000 feet, although here it says "in largest floods." Immediately following in the text the statement is made—

The river is known to have risen somewhat higher, but as no gauging was made at the time the above figures are arbitrarily increased 50 per cent to allow for a greater rise.

Evidently the observations did not cover the high points, because the chief engineer states the river is known to be higher.

I think, gentlemen, you are getting an idea of some of the difficult features we had to contend with in forming an opinion about these matters of which there is such a diversity of opinion. The failure of two statements about the same thing to cohere, some in direct opposition to the facts, made the investigation extraordinarily difficult; and yet if you will read our report you will find it is impartial and impersonal, and constructed on a purely engineering basis without reflections on anybody. We impute nothing to anyone, and then coming before this committee we find everything imputed to us—imbecility, incompetency, inadequacy, and——

Mr. SHERMAN. Where do you find that? I have not read anything to that effect here.

Colonel LUDLOW. You read this as I have been reading it. I read it night before last until 4 o'clock in the morning in order to come before

the committee and talk about it. I did not stay up that late last night, although I was a little late in getting down here. I beg you to believe I am not endeavoring to trifle with the committee about these matters. I recognize their seriousness, and I am fully willing to accept the responsibility for everything I say here, and if anyone will show me to be in error I will be the first to make acknowledgment.

Mr. SHERMAN. I think that statement is an error.

Colonel LUDLOW. Which?

Mr. SHERMAN. That anybody has imputed to you "imbecility," which you stated just now?

Colonel LUDLOW. Now, look here. We were three grown engineers—men of fifty-odd years of age; and they come here and say that we wandered about; that we were fascinated with the novelty of the Tropics, and that getting to the shore we bathed——

Mr. SHERMAN. Was not that proper?

Mr. LUDLOW. I am sorry that it should be found necessary to note it. We thought it was a proper thing. We needed it; but to have inferred from that our inability to handle this canal problem——

Mr. SHERMAN. I do not think anybody could so construe it.

Colonel LUDLOW. I trust not. I will ask the committee to permit me to go back a moment to Mr. Miller's statement, and if so, I will promise not to do so any more. It is in regard to the construction on the river if the Ochoa Dam should fail. That is on page 14 of Mr. Miller's testimony, which only shows how difficult it is to tell the truth. You have to be very careful in engineering questions. It is a delicate matter and you have to qualify yourself and to be sure, because what you say may be capable of misconstruction and people will not understand you. Even in ordinary matters it happens that way, and in technical matters it is very difficult and you have to be very guarded. At the bottom of the page Mr. Bartlett inquired:

Suppose the dam gives way, would it destroy the canal?

Mr. Miller says:

No, sir; the water would go down the original channel of the San Juan and the canal would be left dry and uninjured.

Well, that is true. It was in reference to the statement made by the board that the failure of the dam would destroy the navigation. Mr. Miller considers, however, it would not injure the canal; that the dam might fail, but it would not injure the canal, and that the water would go down the river and the canal be left absolutely safe and unharmed, and he takes the precaution to suggest also that it would be left dry. Now, how much canal is there when the water is out of it? Where is your canal? It is a mere trench in the ground.

Mr. DOOLITTLE. I would like to state in that connection it has been stated to members of the committee that all the embankments along these basins below there would be destroyed by reason of the giving out of the dam. That is the reason why this statement was made there.

Colonel LUDLOW. Then that needs qualification.

Mr. SHERMAN. If the dam gives way, would it destroy the canal?

Mr. WANGER. You seem to agree with him.

Colonel LUDLOW. I think the canal, as a canal, would disappear. It is not a canal without water in it.

Mr. PATTERSON. Evidently Mr. Bartlett had in mind perhaps if the dam was washed away or destroyed that the effect would be to injure

the locks, because of the giving in of the banks and obstruction of the trench?

Colonel LUDLOW. Well, as far as the locks are concerned, they would be on the other side of the divide, and possibly——

Mr. STEWART. You can remove the water from a goblet and the glass itself will not be injured, and the same way with the canal.

Colonel LUDLOW. Is an empty goblet a drink of water?

Mr. STEWART. Not at all. But it is not the cause of that glass of water, and the canal itself and the physical conditions of the embankments, etc., are great items, which I take Mr. Bartlett in his question had reference to?

Colonel LUDLOW. Very well, I will be pleased to answer that; but at the same time I would answer Mr. Miller's idea that, the water running out of the canal, the canal would be uninjured, that a canal without water is still a canal.

Mr. JOY. The idea is the cost of building the canal is $150,000,000, does not mean the water shall be manufactured to fill it up, but the water we get for nothing. The destruction of the canal would not be the destruction of the water. There would be too much water, perhaps, at different places, but the cost of the canal is what it cost to build it, $150,000,000?

Colonel LUDLOW. That is quite true.

Mr. JOY. That is apparently the intention of the question.

Colonel LUDLOW. I think it quite likely. We make the point it would leave navigation stranded and do great damage below.

Mr. PATTERSON. Let me put it to you in that connection. Suppose the dam at Ochoa should be washed out, and the flood would go down the river, as stated here by Mr. Miller?

Colonel LUDLOW. That is stated in our report.

Mr. PATTERSON. Now, would that affect the channel of the canal?

Colonel LUDLOW. Yes, sir; I think it would—very seriously.

Mr. PATTERSON. In other words, if the dam was reconstructed, would anything have occurred in the meantime to interfere possibly with the navigation of the canal?

Colonel LUDLOW. Well, I will answer that directly. The point of danger to the canal banks in the case of the failure of the Ochoa Dam would be this great embankment, which 2 miles below the Ochoa Dam constitutes the banks of the canal. There are tremendous great clay fills, and it is what is known as the San Francisco embankment, and the outrush of this great body of water downstream would undoubtedly have a very serious effect and might have a destroying effect on those banks.

Mr. DOOLITTLE. Well, if they are built of sufficient thickness and of proper material rightly placed, you do not think these banks will slide in or out?

Colonel LUDLOW. A clay fill with such a body of water pouring against it melts away pretty rapidly. You remember the Johnstown flood?

Mr. DOOLITTLE. Quite well.

Colonel LUDLOW. There were some features in connection with that which somewhat apply to this, supposing that dam should break at Ochoa. Furthermore, you would have the stranding of the ships which might be in that canal, which would not be very comfortable for them.

Mr. DOOLITTLE. But you believe these embankments might be so constructed that they would stand?

Colonel LUDLOW. Not easily; no, sir.

Mr. DOOLITTLE. Not easily; but I mean with professional ease.

Colonel LUDLOW. They never would stand that kind of a rush. I think the action of a powerful current against them on the outside would be very destructive. Any engineer will tell you that. Then, there would be no canal at all until you could build it again, and for four or five years traffic would cease until the dam and banks were restored. I noted that, because I thought possibly some members of the committee wanted information on that subject, as it was an interesting point. In regard to the flood in the San Juan, we have two differing statements of that flood by the chief engineer, one in one paper and one in the other, relating to the same subject and same observations.

Mr. WANGER. Is there any serious difficulty except the expense of facing the embankments from the cut?

Colonel LUDLOW. The San Francisco embankments? It would probably be extremely desirable to cover them with a riprap of rock to protect them from the wash of the rainfall.

Mr. NOONAN. The testimony here is that these clay banks are not susceptible to rainfalls, and that they stand there well.

Colonel LUDLOW. Yes; another misapprehension, you see. If the committee has that idea, I would like to correct it.

Mr. NOONAN. We would like to hear that, because the specific statement was made here that the marks are still visible made in the cuts, etc., while at work there?

Colonel LUDLOW. Precisely; the board makes that statement. We put that in our report.

Mr. NOONAN. Then, what is the necessity for riprapping?

Colonel LUDLOW. For the simple reason that a cut in solidified material is a very different thing from piling up material to make a bank. You get in one case the earth naturally consolidated in which to make that cut. When you undertake to take that material out and dump it and try to solidify it, there is where the trouble begins, and that is the serious problem relating to the building of these dams in order to solidify them and make them hard, compact, and water-tight against these tremendous amounts of water.

Mr. DOOLITTLE. That would be tamping and all that process which you use?

Colonel LUDLOW. In my mind I do not know exactly how you can do that, and as we say in our report it is difficult. Ordinarily it would be done by animals hauling rollers over it trying to solidify it in six-inch layers. That is the way a reservoir bank is built, but in this case you possibly can not get your animals out on this bank. You have got there a vast quantity of clay which is mud when you wet it, and it will never have a chance to get dry, and you can not roll it over, and if you try to put animals out on it they could not get far enough to pull anything, and you will find in the report there we suggest it will probably have to be done by overhead cable which you would use to deposit material, and you use the same power, if you choose, to haul these rollers to and fro. You can not adopt ordinary methods of doing it.

Mr. DOOLITTLE. Do you assume the land can be solidified so as to make it impervious to water by this process?

Colonel LUDLOW. I do not assume, but I should hope to do so; I should try to do so in some way. That construction, you understand, of clay dams is really one of the most serious things in the engineering.

Mr. DOOLITTLE. It is the most important in this thing?

Colonel LUDLOW. It is extremely important for the construction of that San Francisco embankment, and it is admitted by the chief engi-

neer himself that he regards it as the most difficult and dangerous work on the whole route.

Mr. DOOLITTLE. That is the real key to a large part of the situation, so far as the canal project is concerned. That was the strip you said Mr. Menocal had not passed over yesterday?

Colonel LUDLOW. Yes, sir; there was some portion of it there. There are two lines there—the canal line and the embankment line. The canal goes through the bottom of the basin, and you do not do anything on the canal line because it is drowned out. Mr. Menocal says he regards that embankment line as the most dangerous part of the whole work.

Mr. DOOLITTLE. The most important part, does he not state?

Colonel LUDLOW. Where does he speak of that?

Mr. ENDICOTT. He says that is the weakest part. You will find it in the report of 1890.

Mr. PATTERSON. That is immaterial.

Mr. DOOLITTLE. Of course it is. I merely referred to it in passing and do not care to take up time with it.

Colonel LUDLOW. We had that matter about having passed by the site of the Ochoa Dam and, I only wanted to say we landed Sunday afternoon. We took that afternoon to examine the site of the dam and the whole vicinity of it on that side. There was not much to see, but we went on up the line of the crest and put in a most difficult afternoon's work, and the next morning we crossed the river and examined the other bank, went over every slope, examined the hills where the dam was to land, and continued and went on up this San Carlos ridge 10 or 12 miles.

Mr. DOOLITTLE. Where is the earth to come from to build this San Francisco embankment?

Colonel LUDLOW. It was proposed to take the greater part, or perhaps all of it—the canal project rather indicates they should get the whole amount of it, from the excavation of the east divide cut. There is a very heavy body of clay overlying the rock and it is proposed to use that. There is not really, as a matter of fact, enough clay in that divide to build these embankments.

Mr. DOOLITTLE. But there is plenty in the adjacent hills?

Colonel LUDLOW. Yes; you would have to borrow from the neighborhood.

Mr. NOONAN. I understand you have seen the embankments in India?

Colonel LUDLOW. No; I have never been there. I would like to, but I have only seen the drawings and technical accounts of them. I have some books which I was able to have sent over from London last summer while we were examining this thing. You will find some data on that subject in our report about these India weirs. They are very interesting structures and very peculiar. They have been built there for a long time; some of them are very ancient.

Mr. NOONAN. I supposed that was part of your mission.

Colonel LUDLOW. I should have been very glad to have gone there, but if I had gone that far I might not have had the pleasure of getting back to meet the committee. They, however, only gave me certain designated points which I was to go to see. If it had not been for the Nicaragua Canal matter I should perhaps have been in India, as I hoped to arrange it as military attaché there.

Really I think in a certain sense there is an explanation of a good many of these things, the confusion between preliminary survey and final survey and the necessity for further survey and all that, as indi-

cated by Mr. Menocal in the middle of page 55, where he states, which really I did not know and had not in mind at all, because I did not look into the matter:

The final survey should be completed within eighteen months from the date of the concession.

That is all right; of course surveys had to be completed in the sense of being completed and prepared and sufficiently coherent to answer such purpose. The mistake, of course, was retaining it as a finality, using it otherwise.

Mr. DOOLITTLE. Do you think in going over all these statements made by Senator Miller and Mr. Menocal that they have ever professed that no more surveys or investigations were necessary up to the time work should be completed? Are not these surveys going on continuously, always during the performance of any great work on railroads or anything else?

Colonel LUDLOW. Not usually; no.

Mr. DOOLITTLE. Are not engineers constantly engaged on the work making surveys?

Colonel LUDLOW. After you build a railroad?

Mr. DOOLITTLE. While you are constructing a railroad or any other great engineering work.

Colonel LUDLOW. Oh, certainly. But it does not follow that you do not have to make an investigation thoroughly at the start, or that you can go on and build and survey concurrently. Some portion of this canal you can start to-morrow; the information is ample. There is plenty of this work you can start in on to-morrow, if you desire so to do. The object of a survey is to determine what to do and what is best to do; that is all.

Mr. DOOLITTLE. To such an extent as would require the expenditure of a million of dollars or so?

Colonel LUDLOW. That is very true. You can commence improving the San Juan River to-morrow.

Mr. DOOLITTLE. And the rock cut?

Colonel LUDLOW. Yes, sir; and dredging out on the lake.

Mr. JOY. There was a question I wanted to ask last night. You say you found the level of the Lake Nicaragua varied several feet, and you still admit the canal is a feasible project. I want to ask you how, in your opinion, that level of the lake could be maintained, or the canal or river between the Ochoa Dam and the lake could be maintained, at a stable depth with the lake changing in its level to the extent you indicate it?

Colonel LUDLOW. You have got to control it.

Mr. JOY. By what means and in what direction? I ask for personal information.

Colonel LUDLOW. Quite right, and it is a matter to which the board gave days and nights of most careful consideration, using the data we had. You will find it treated at considerable length in our report.

Mr. JOY. I read that, but it was not as complete as possible, and I thought perhaps at this time you would be able to elucidate it.

Colonel LUDLOW. If I had a diagram, I could explain it better perhaps; but our discussion, if you please, in the report was based upon the idea that the lake was not to be allowed to fall below a certain fixed quantity.

Mr. JOY. You say there is a difference of 3 feet, 5 feet, or more in the level of the lake. Could that difference be overcome to such an extent

as to maintain the river above the Ochoa Dams at 30 feet of water, or a given depth of water?

Colonel LUDLOW. We think it can be done.

Mr. JOY. But what means would you adopt to do it?

Colonel LUDLOW. The first thing to do would be to raise the Ochoa Dam and everything that applied to it to an elevation sufficient to maintain the lake surface at or above the datum you determine to have. In these circumstances, as the Board looks at the matter, during the dry season, while the lake is wasting and the rains are not falling, the water surface will be practically horizontal in the lake, and all the way down the river to the dam practically horizontal; and, in fact, the Board considered it might even be necessary in the dry season to make the elevation such as to hold the water to a higher level than the datum plane or summit level, in order to allow for a possible fall. Then, having done that, the difficulty comes in the rainy season when the lake begins to rise, and it is evident, unless you are going to drown out that basin and allow the whole variation of the lake to accumulate on the top of that summit level and fill up there, you will have to make some provision for letting it run off. So that, whereas in the dry season the slope is horizontal, in the wet season you have to steepen that slope, in order to prevent the accumulation of water, and you have to discharge the surplus water out of the lake, and consequently have to have a steeper slope to do so. Therefore, it involves the necessity of having some arrangement, some adjustment at the dam which can be worked so as to shut and open, either sluices or movable weirs, so as to hold the water up by shutting the gates, and when the weirs are open to let the flood go out that would otherwise drown out the basin above.

Mr. JOY. Is there any considerable portion of the country between this point—Ochoa Dam and the lake—which at high water with the Ochoa Dam built of sufficient elevation would be continually overflowed by the deepening of that river and the backing up the water?

Colonel LUDLOW. In the valley it is; it would be enormously overflowed. We raise the water at Ochoa sixty odd feet. It is proposed by that dam to flood that whole valley, and the San Carlos Valley to boot, all the way back to the lake. You make a vast expanse of water there where the banks are low. Of course, where the banks are high you only flood what the water reaches. It is the same way up the San Carlos Valley. There are twenty odd miles that will be flooded. You do not, however, want to drown any more land in there than you can help.

Now, I could multiply the points that these people have objected to, but I will not impose on the committee. I am at the Chairman's service now.

The CHAIRMAN. I wish you would give us some information of what you observed there of the remains of work done by the company in the general furtherance of this enterprise, either at Greytown or anywhere in regard to piers, excavations, etc.

Colonel LUDLOW. The work done by the company was concentrated at Greytown; that is, all the construction work was done there.

The CHAIRMAN. What did you find remained of their work?

Colonel LUDLOW. We found the remains of dredging of the harbor in the shape of mounds of sand thrown up by the dredgers when they were excavating there. We found the remains of a pier at the beach. We found three-fourths of a mile of canal excavated from the Greytown lagoon in the direction of the canal toward the hills. We found a railroad 11 or 12 miles running from Greytown to the foothills to the

site of the locks. We found several dredges, and we found a large number of buildings—extensive buildings—hospitals, headquarters, offices, and resident buildings belonging to the company and built by them. I think that covers about all of the construction and plant we noticed. There were locomotives, etc., and quite a variety of material.

The CHAIRMAN. What did you find in regard to the channel in the harbor?

Colonel LUDLOW. There is no channel. The channel that was made by the company when they were working there is completely filled up. It could only be kept open by dredging.

The CHAIRMAN. Will that be the case for all time? Will it be possible to secure by any engineering device a channel that would preserve itself?

Colonel LUDLOW. No, I regard that as out of the question. That is hardly the case anywhere, Mr. Chairman.

The CHAIRMAN. What is your idea, or did you make any estimates of the annual dredging that would be necessary to preserve a channel commensurate with the uses of the canal?

Colonel LUDLOW. No, sir; we really did not go into that inquiry at all.

The CHAIRMAN. In your judgment, will that be a matter of considerable cost?

Colonel LUDLOW. There will be, I think, a considerable cost for maintenance there.

The CHAIRMAN. To what distance seaward will they have to use the dredges in order to preserve a 28-foot or 30-foot channel?

Colonel LUDLOW. They would have to go at least that far.

The CHAIRMAN. How far?

Colonel LUDLOW. To the 28 and 30 foot depth. I do not know how far that would be.

The CHAIRMAN. But how far from the shore?

Colonel LUDLOW. That would depend on the rapidity with which the shore moved out. It was found on the east side of the pier built by the company that the beach followed out—that the sand accumulated against it on the east side followed very rapidly toward the end of the pier until when we were there the shore line was out fully to the end of the pier and the beach had swept on by and made a dry bar on the other side, the entrance being at some little distance from the pier.

The CHAIRMAN. What machinery did you find there?

Colonel LUDLOW. We found three or four dredges which were the most prominent objects. There were machine shops and a lot of boats, scows, and so on, on the bank; quite an accumulation of material of various kinds—three or four locomotives and sheds. The pier was there.

The CHAIRMAN. What was its condition?

Colonel LUDLOW. Well, its condition was—the woodwork was about gone, and the piles had been badly eaten by the teredo and the timber was much decayed; but some was in pretty fair condition, as there was concrete inside——

The CHAIRMAN. Would any of it be of value now in completing the canal, or would it have to be replaced?

Colonel LUDLOW. It would, provided the entrance to the harbor was retained at the place proposed by the company.

The CHAIRMAN. Suppose that entrance was retained, what would you estimate the present value of that work?

Colonel LUDLOW. Well, in a case like that, of course it has no commercial value——

The CHAIRMAN. But as part of the completed construction?

Colonel LUDLOW. It has no commercial value in such a case, and the value of a work like this is its usefulness. In one way I should say the value of that work is exactly the price it would cost to put something in there to do the same work.

The CHAIRMAN. That is what I meant to be understood?

Colonel LUDLOW. That is what I think. I think the present value of that work is about what it would cost to substitute something if it were not there.

The CHAIRMAN. The line of this questioning and the purpose of it is this: I want to find out what there is of value there now—its present value as a part of this great enterprise?

Colonel LUDLOW. The value of the jetty depends entirely upon whether you propose to keep the entrance there or not.

The CHAIRMAN. Suppose you did?

Colonel LUDLOW. Then the jetty is worth what it would cost to put something there to take the place of it.

The CHAIRMAN. What would that cost?

Colonel LUDLOW. There is 900 feet of it, I think.

The CHAIRMAN. Just approximate it.

Colonel LUDLOW. We estimate to put in a jetty—I generally like to speak by the book, if I can find it—we estimated to put in a temporary pile jetty for temporary purposes of securing an entrance. That is estimated at about, I think, $70 a foot. The board, however, does not believe we ought to endeavor to make an entrance there.

Mr. DOOLITTLE. This is only a temporary pier, and does not include the rock work, which is of course the most important of all things in connection with the jetty.

Colonel LUDLOW. That does not include final rock work, but it has rock in it.

Mr. JOY. That would be $63,000.

The CHAIRMAN. What are these dredges worth?

Colonel LUDLOW. I do not know. I do not think they are worth anything. The woodwork is worth nothing; what the machinery is worth, what condition it is in I do not know, but it is badly rusted and worn out, and is of an ancient type anyway. I do not think it would pay to try to use those dredges except for temporary purposes.

The CHAIRMAN. What do you estimate the present value of the railroad and its rolling stock?

Colonel LUDLOW. Well, the rolling stock I should not charge up as worth anything. I do not know what is the condition of the locomotives. They were under the sheds, but the climate is very trying on ironwork and they are rusted up. I would lump the whole business, rolling stock and dredges, and let somebody take it for scrap. The roadbed is there and has a definite value and is worth what it cost, practically.

The CHAIRMAN. How much would it cost to make the excavation that has been made in the canal proper?

Colonel LUDLOW. To make that same excavation? I do not remember the cube of it which was taken out.

Mr. ENDICOTT. It cost them $80,000 at 11 cents a yard.

Colonel LUDLOW. That is its value provided you retain the entrance where it is.

The CHAIRMAN. But if you change the harbor, that would be lost?

Colonel LUDLOW. Oh, yes; you lose any use of the pier.

The CHAIRMAN. What is the value of the buildings?

Colonel LUDLOW. I do not know, sir. We found the buildings in very fair condition; they are in good condition indeed considering the time they have been there and the lack of care they had.

The CHAIRMAN. Can you give the value approximately?

Colonel LUDLOW. I do not know really what the buildings cost. I understand, however, they cost a great deal, because they came from Chicago and had to be shipped and put up again, and so on. Of course there is nothing in the country to do anything with, and I presume the cost was something frightful.

The CHAIRMAN. What would be a fair estimate of the cost of accumulating the engineering data that you regard is of value?

Colonel LUDLOW. Well, we estimated the cost of getting what was imperatively needed at $350,000.

The CHAIRMAN. What I want to find out is, what would be a fair estimate of the cost of that which they had accumulated, that is, of present value?

Colonel LUDLOW. Well, you see, all the information they have accumulated is of value. I do not know what their expenses were; perhaps $250,000 or $300,000, but I do not know; but I should say it was that. They were there a good deal and had a good many parties out. At one time they had as many as eight small parties, I think, out. I think those surveys ought to be worth what it cost to get them.

The CHAIRMAN. What portion of the canal has been cleared of timber?

Colonel LUDLOW. Of the wood? Why, a large part of it has been. I do not think it has been cleared from Greytown to the foothills on the canal route.

Mr. ENDICOTT. Not in there by Lock No. 1.

Colonel LUDLOW. I do not think that part has been cleared. There is no use clearing in there, as it is swamp. A picket has been cut out quite wide and comparatively clear through the east divide cut, and it is comparatively cleared through the San Francisco district, not necessarily over the canal line, because much of that runs in the bottoms which will be drowned out according to the project. There is a picket cut out on the crest line, so we could follow it. Well, that is all about as far as Ochoa. Over on the San Carlos ridge there is a picket there partly cut out. On the west side the clearing there has been quite extensive, quite broad, several hundred feet or more, and from the lake seaward until you get to the divide——

Mr. ENDICOTT. There is practically no timber in there.

Colonel LUDLOW. There is no standing timber in that region. For heavy tropical timber it is too dry in the summer.

The CHAIRMAN. Is that portion reaching from Greytown to the hills submerged?

Colonel LUDLOW. It is swamp and of tropical growth.

The CHAIRMAN. Did you traverse that?

Colonel LUDLOW. We could not. We went over the railroad three times. You can not go through that swamp except by a canoe or something of the kind, and there is no object in going over it. It is swamp, and naturally you go up by railroad and see what the construction is. There is no use of wading through a lake or swamp, as you can look at it for five minutes and know as much as if you looked at it for five years.

The CHAIRMAN. All of that work will be submerged excavation?

Colonel LUDLOW. Yes; that will be wet excavation, dredging work.

Mr. DOOLITTLE. Will not that drain that swamp when it is constructed?

Colonel LUDLOW. Oh, yes; it will assist materially in doing it. Of course you can not get it dry with the rainfall, but it will help materially.

Mr. DOOLITTLE. The railroad is built through the same character of land, is it not?

Colonel LUDLOW. No; it gets a little difficult as you get farther along—the part down here is sand and a little clay, and as you go farther along you lose the sand.

Mr. DOOLITTLE. I mean the railroad as built there is in the swamp?

Colonel LUDLOW. So far as anybody knows, it is just the same—a mixture of sand, mud, and clay.

Mr. NOONAN. I understood Mr. Menocal to say when you were there you designated another point of entrance to the harbor?

Colonel LUDLOW. Yes, sir.

Mr. NOONAN. Why were you impelled to do that?

Colonel LUDLOW. We treated at some length the reasons for that in our report. We believed there was certainly danger of starting in on a hopeless fight to make an entrance there, because it is too near the west beach. The sand accumulates there from both directions.

Mr. NOONAN. Well, the filling you speak of; will you avoid that by having the new place?

Colonel LUDLOW. You will not avoid all the filling, but you will have it in a reduced quantity. You get better conditions. Furthermore, going a little farther down and running at right angles to the beach you get 8 fathoms of water, which on this route is reached at 2,000 feet from shore, and we believe at less trouble of maintenance. That is the real reason of changing the position.

Mr. DOOLITTLE. Which is the direction of the drift given by the current?

Colonel LUDLOW. There is no current.

Mr. DOOLITTLE. Well, I mean by the sea?

Colonel LUDLOW. The action of the wind on the beach?

Mr. DOOLITTLE. I mean the current there.

Colonel LUDLOW. It has no current.

Mr. DOOLITTLE. Is not there a current setting in from the northwest down there? Do not the winds prevail from that direction?

Colonel LUDLOW. The winds blow from about east to northeast.

Mr. DOOLITTLE. The sand then drifts about that point?

Colonel LUDLOW. We have not a map here on which I could show you. This large affair is not a map, but a diagram intended to illustrate the general features of the project; but perhaps I can do something with it. Near that projecting point of land called Harbor Head there is a nearly open sea, and when the waves come in at about an angle of 45 degrees on the beach it runs a little southwesterly to a point toward the town. Then the beach takes a turn and goes up this way [illustrating] and curves up well from there and makes a bay like this, and there is another cape called Monkey Point, which is about due north of Greytown, making a bay. We found reasons to believe and are entirely satisfied that the sand was moving in both directions into the head of that funnel, which is due largely to the wave action. The sea is perpetually coming in there, and, under the action of the trade winds, striking the shore at an angle of 45 degrees, mounting upon the beach and receding, and coming again and again, makes an action upon the beach which carries this light sand in here [illustrating].

Mr. DOOLITTLE. How far do you go from the proposed mouth of the canal until you reach, say, 8 fathoms of water?

Colonel LUDLOW. The present mouth? I will have to find that in *our report.*

Mr. DOOLITTLE. I would just ask you first if you ran lines out and made soundings in order to ascertain?

Colonel LUDLOW. Oh, yes; we made a beautiful map of the whole thing. That is to say, the officers of the *Montgomery* did the hydrographic or offshore part, while we did the shore part, and so we have a handsome map of it. We say, on page 37 of our report:

> But it seems safe to conclude that the endeavor to construct a harbor entrance for the canal immediately adjacent to the head of the bight, where the maximum filling action from both directions must take place, will involve engaging at once in a perpetual contest with forces of great power and persistence at the point of application of their resultant efforts. On the prolongation of the comany's piers the 6-fathom curve is over 1,500 feet distant from the shore, the 7-fathom curve 4,000 feet, and the 8-fathom curve about 8,000 feet.

Mr. DOOLITTLE. About 8,000 feet seaward?

Colonel LUDLOW. On the line of the pier.

Mr. DOOLITTLE. That is no longer than the pier at the mouth of the Columbia River?

Colonel LUDLOW. It is no extravagant length, but if you can have it less length——

Mr. DOOLITTLE. But a pier built out there would have the same effect as it had at the mouth of the Columbia?

Colonel LUDLOW. It might—no.

Mr. DOOLITTLE. Why would it not have? There is no current out there; there is no flow of water there. It is on the broad Pacific, and the jetty is built to resist the encroachment of the sand washed down and drifted by the sea.

Colonel LUDLOW. And also incidentally to control and guide the current of the Columbia River.

Mr. DOOLITTLE. That goes to sea; stretches clear to the northward 30 miles.

Colonel LUDLOW. Do you remember before the Columbia jetty was built?

Mr. DOOLITTLE. Yes, sir; I have been there many a time when there was not 16 feet of water there.

Colonel LUDLOW. There were three channels. Now there is but one, and the purpose of that jetty was to hold the river just where it is.

Mr. DOOLITTLE. The purpose of the jetty, as I understand the engineers engaged in the work and who were with me when I went out on the end of the jetty, was to resist the encroachment of the sea washing from the southward and the force of winds and currents.

Colonel LUDLOW. And did it very successfully.

Mr. DOOLITTLE. And they have 32 feet of water.

Colonel LUDLOW. They have the advantage there of a tremendous river to work with, with an enormous flood and of great volume. If they had not had that they would have had to fight its tremendous force——

Mr. DOOLITTLE. But the effect of that pier would be to arrest the sand drifts?

Colonel LUDLOW. Yes; arrest the sand drifting from the west and guide the river, so that instead of spreading out and wandering about it is concentrated.

Mr. DOOLITTLE. At Greytown?

Colonel LUDLOW. No; at the mouth of the Columbia.

Mr. DOOLITTLE. But I am speaking about building piers at Greytown, and I say they arrest the washing of the sand when they are built out seaward far enough.

Colonel LUDLOW. Assuredly.

Mr. DOOLITTLE. And the channel could be made permanent?

Colonel LUDLOW. Yes; it can be.

Mr. NOONAN. Would you have any objection to stating in writing to supplement what you have stated in regard to that opening?

Colonel LUDLOW. How is that?

Mr. NOONAN. In regard to this entrance to the harbor here?

Colonel LUDLOW. Well, in connection with that I will try to do it from the estimates; I have no other means of doing it.

Mr. NOONAN. I do not believe you can do it in a cursory way, and that is why I asked you to put it supplementary in writing.

Colonel LUDLOW. It would be very difficult. We estimate the total cost of the Greytown Harbor, making a provisional estimate of $4,480,000, warehouse, machine shops, wharves, railroad trestles, stone—you do not want that estimate at all?

Mr. NOONAN. Oh, no; simply an estimate of the feasibility of making that channel there adequate for the purposes indicated where you propose to put it.

Colonel LUDLOW. Very good; that involves the construction of a temporary pile pier in order to secure an entrance, and then piers of loose rock, which is in addition to the rock in the temporary piers, piers at entrance to canal, dredging, stone pitching, channel banks, etc., nearly $4,000,000 all told, including the dredging of the harbor. The whole interior harbor dredging is included in that. The items are not separated here in the estimate for the dredging. The harbor work proper, as we made a preliminary estimate, would be about $900,000; say, in round numbers a million of dollars.

Thereupon the committee adjourned to meet at 2 p. m. on Thursday, April 30, 1896.

COMMITTEE ON INTERSTATE AND FOREIGN COMMERCE,
HOUSE OF REPRESENTATIVES,
May 4, 1896.

The committee met at 10.30 a. m., Hon. William P. Hepburn in the chair.

STATEMENT OF COL. WILLIAM LUDLOW—Continued.

The CHAIRMAN. Colonel Ludlow will proceed with his statement.

Colonel LUDLOW. Mr. Doolittle stated that he would take up the question of estimates, etc., to-day and ask some questions in that connection. Of course, this is a difficult and complicated matter. You can understand that it is especially difficult to form an accurate estimate upon a matter concerning which we have not complete data. Mr. Noble, of our board, was very much engaged in important work in New York, but he was good enough to come over yesterday and we three—Mr. Endicott, Mr. Noble, and myself—went over the data and figures that we have. Mr. Noble, although at very great inconvenience, arranged to remain over to-day. Before you proceed with the questions that you desire to ask, inasmuch as I was responsible for the introduction of Mr. Davis's name in my testimony the other day, and some questions were asked which might indicate there was something against him, I would be glad, with the permission of the committee, to read two short communications touching this matter. I have taken a little trouble to ascertain what the facts were in that regard. With

your permission I will therefore read these papers, and leave them as a part of the record. The first is from the Engineering News of August 22, 1891, as follows:

Mr. Frank P. Davis, now the chief assistant of Engineer Menocal, of the Nicaragua Canal Construction Company, stationed at Greytown, Nicaragua, has been the recipient of so unusual a mark of recoguition for services rendered as an engineer that we give the resolution of the company in full, and congratulate Mr. Davis on his good fortune and the officers of the Canadian Pacific Railway on their frank admission of indebtedness to their engineer for good work done eight years ago. The resolution reads as follows:

"At a meeting of the board of directors of the Canadian Pacific Railway Company, held at the principal offices of the company in Montreal, on Monday, the 8th day of June, 1891, the president referred to the especially valuable services of Mr. Frank P. Davis, who as engineer on the Rocky Mountain section of the line, under Maj. A. B. Rogers, prevented a most serious mistake in the location of the railway in the Lower Kicking Horse Canyon, and saved the company a large amount of money in its original construction, as well as in its subsequent operation, and stated that when the facts came to the knowledge of the executive officers they felt that Mr. Davis's services should be fittingly recognized, and that Mr. Davis had left the country and his place of residence was not known until within a few weeks.

"The president recommended that a check for a suitable amount be sent to Mr. Davis, with a resolution expressing the appreciation of the board; whereupon it was

"*Resolved*, That the recommendation of the president be concurred in, and that he be authorized to forward to Mr. Frank P. Davis a check for $1,000, together with a copy of this resolution, as an acknowledgment of the valuable services rendered by him to this company.

"Attest:

"C. WAINWRIGHT, *Secretary*."

The second paper is from the office of the Engineer Commissioner of the District, and is signed by the computing engineer and superintendent of sewers of the same service. This came to me with the knowledge and approval of the Engineer Commissioner, Major Powell. It is as follows:

OFFICE OF THE ENGINEER COMMISSIONER,
DISTRICT OF COLUMBIA,
Washington, April 30, 1896.

DEAR SIR: In answer to your inquiry concerning the record of Mr. Frank P. Davis, while connected with the engineer department of the District government, I make the following statement:

He was appointed assistant engineer November 1, 1884. On December 1, 1887, he was granted leave of absence, without pay, and went to Nicaragua on some preliminary surveys. August 1, 1888, he resumed his position as assistant engineer, and retained it until May 31, 1889, when, having been engaged on the Nicaraguan Canal Construction, his connection with this department was severed.

During the time he was engaged here he proved himself a capable and reliable engineer. His work was under my supervision, and I am therefore able to speak with confidence as to its character. It was in all respects acceptable, and I regard him as a thoroughly conscientious and honest man, whose statements on any subject with which he is familiar I would accept as truth.

Very respectfully,

GEO. H. BAILEY,
Computing Engineer, Engineer Department, District of Columbia.

I indorse the above statement.

D. E. MCCOMB,
Superintendent Sewers.

Col. WILLIAM LUDLOW,
Corps of Engineers, U. S. A.

Mr. DOOLITTLE. Did you have those papers with you when you appeared before the committee the last time?

Colonel LUDLOW. I had not.

Mr. DOOLITTLE. Where did this paper come from, and how came you in possession of this paper from the Canadian Pacific Railway Company if it was written in 1891?

Colonel LUDLOW. From the same source from which I obtained the other paper. It is a part of the record in the District office. It came to me from Mr. Bailey with a note from Major Powell, Engineer Commissioner.

Mr. DOOLITTE. Mr. Chairman and gentlemen of the committee, I desire here to say that I wish to proceed and ask Colonel Ludlow a line of questions—the gentleman who has last made a statement before the committee—relative to the estimates and quantities in this canal work. I have a line of questions which I think he will have no difficulty in answering, and if Colonel Ludlow, when I ask these questions, will be kind enough to confine himself to answers to the questions, it will expedite the matter very much, and I shall in every instance make them as brief as possible.

The CHAIRMAN. Those questions are in the nature of a cross-examination?

Mr. DOOLITTLE. Yes, or inquiry.

The CHAIRMAN. They will not be pertinent, I understand, until Colonel Ludlow finishes his statement?

Mr. DOOLITTLE. Certainly; I do not desire to proceed until he has gotten through with his remarks.

The CHAIRMAN. Do I understand that you have completed your statement, Colonel Ludlow?

Colonel LUDLOW. Not entirely, perhaps. There are one or two matters I would like to bring before the committee, although, of course, I am quite at the disposal of the committee, and I would be glad to answer questions whenever members of the committee desire to put them. I was advised last time by Mr. Doolittle that estimates was the matter about which questions would be asked. There are one or two points I would like to cover, because the effect is rather important. One in particular is this question of summit level. This is a question which has given the board great concern. We assumed all the way through that there was a fixed summit level to be maintained, and we must admit to have been very much surprised by the statement of Mr. Menocal that it was not expected to maintain a fixed summit level, but that such level was expected to vary with the rise and fall of the lake, above or below the 110 feet, according to the oscillations of the lake. That we regarded as a very extraordinary proposition, and we were quite disconcerted to find that the view we had held on this point was in error. I want to read, merely in justification of our view, some testimony given by Mr. Menocal, embodied in Senator Sherman's report of December 2, 1892. It contains a large amount of very interesting information. On page 174 I find the following testimony:

Q. How much is the rise and fall of Lake Nicaragua, in its present natural condition, from extreme high water to extreme low water?

Mr. Menocal answers:

From 2½ to 5 feet. We propose to retain the level of the lake at 110 feet.

That was the summit level. The answer is distinctly made that it is proposed to retain the level of the lake at 110. That is, of course, what we have always understood. There are some more questions as to what the variations might be:

Q. How much will that swell it above its lowest natural condition?—A. Six and one-half feet.

Q. So that that will carry it up to a height of 2 or 3 feet above its ordinary high water?—A. Yes; but 110 feet is not above the highest water mark by any means.

Then he was asked whether the lake would rise enough to kill trees or overflow shores that are now never covered. His answer was—

No, sir; I would not say never, for sometimes the water reaches an elevation above 112 feet.

Of course, if the summit level is to be maintained at 110 feet and the lake shall not fall below that, whatever rise takes place in the lake will be above that 110-foot level. We made an effort to ascertain what that might be, but we could not do it. We tried to figure out whether the lake could be controlled, so as not to have a rise above 3 feet, but we approximately calculated that that would involve a discharge at times very much larger than at any time has been attributed to the San Juan from the lake.

I wanted to read this, because it is a part of the record and it is information upon which we acted.

Now, there is another point, Mr. Chairman, if you please.

Mr. Menocal, in his Chicago paper, prepared for the World's Columbian Water Commerce Congress, 1893, addressed specifically to the engineer world, at the bottom of page 33, makes the following statement with reference to the construction of locks. He says, very properly:

The matter of safety is of first consideration, but with the exercise of proper care and engineering skill the plans proposed can be successfully carried out. In the proposed plan for a lock canal at Panama, lifts of 36 feet, with a possible maximum of 46 feet at high water, were adopted by the Commission; but we can not recall any ship-canal lock in actual operation with lifts approaching these figures. Yet, in working out the problem, the mechanical details, although necessarily of large proportions, have not so far developed any insurmountable difficulties, either in construction or manipulation afterwards. The body of the locks is to be of concrete, with cut stones in the miter sills, the hollow quoins and such angles as need protection from shocks.

That is a specific and clear statement, and naturally we expected to find that verified in the data. When we came to investigate we were disappointed in not finding it verified. We could not find that there was any cut stone in the lock construction at all—nothing but concrete; not any other material. That, of course, is one of the gravest objections we have to the company's plan. Furthermore, when we asked for the lock drawings at the company's office we found that practically they had none. The construction of these locks is very important and difficult, and they have unexampled dimensions in the way of lift.

Mr. DOOLITTLE. What is the lift, taking them up in their order?

Colonel LUDLOW. As proposed by the company?

Mr. DOOLITTLE. Yes, sir; in approaching the divide from Greytown.

Colonel LUDLOW. The lift is varied a little. It was, if I remember, 30, 31, and 45 feet. The extreme lift, as proposed in the report of 1890, was 45 feet for Lock No. 3. A lock of half that lift has yet to be built.

What I want to submit is the fact that the only data which the com pany was prepared to furnish us, upon which their computations and calculations for these locks were based, is the paper of which this is a copy [exhibiting paper]. By examining it you will see they are simply little cross sections, roughly made, and from these the quantities of concrete supposed to be contained in the lock are computed, and the unit price attached to it, and the total figured out. There were no other plans or data on the subject so far as we could ascertain.

I might say that there was an unfinished drawing in the office of the company, but it was laid aside and we were assured that it was not

used in the preparation of the estimates. The verification of the statement that the company had no other data or plans upon which to base their estimates is the fact that the total estimates for locks 1, 2, and 3, in the report of 1890, are precisely the same as the figures here given on this sheet.

Mr. DOOLITTLE. The total of the locks is the same?

Colonel LUDLOW. Yes; precisely as here stated.

Now, with regard to the construction of the Ochoa Dam; this was another point the board had the utmost difficulty in endeavoring to get to the merits of. I assure you one of the greatest difficulties we had was to ascertain what the real facts were and reconcile the different statements made at different times with what we found the company's own records showed.

This is a blue print of the only drawing which gave us any idea as to the condition of things at the Ochoa Dam. It is admitted that the drawing is obsolete, in the sense that the proposed method of construction here was abandoned. The company, at that time, was proposing a trestlework across the river from which the stone should be dumped. Later this plan was advantageously replaced by the proposition of suspended cables across the river, which, of course, was vastly better. That proposition was never worked out, and the only thing we had to look at was the cross section of the dam, and the only thing we had to give us some kind of an idea as to how they were to build it was the drawing of which this is the blue print. One of the peculiar features of this blue print is that underlying the site of the dam, and extending entirely across the river and up the banks, is shown a ledge of solid rock, and the company's declaration in reference to that—the statement of Mr. Menocal is on record—that underlying the site the materials are "gravel, clay, and rock," in the order named. Now, I can only assure you that borings of the company themselves show that this profile is the only authority for such a statement——

Mr. DOOLITTLE. What is the date of that profile?

Colonel LUDLOW. This antedates the borings, made before the borings were made, when there was no specific information on the subject.

Mr. DOOLITTLE. Which profile you say is now obsolete?

Colonel LUDLOW. Yes.

Mr. DOOLITTLE. The overhead cable was developed, was it not, after the time you have spoken of, when a trestle was to be built across the river?

Colonel LUDLOW. I don't remember about the time of the development of that overhead cable.

Mr. DOOLITTLE. That is a comparatively recent system, isn't it?

Colonel LUDLOW. Yes; I think it has been developed within a few years. I forget how far back the Lidgerwoods have worked with their cables.

Mr. NOBLE. Eight or ten years.

Colonel LUDLOW. It is an excellent method. We are not criticising that method in the least. If it is done, that will be the way it will be done. It was this endeavor to reconcile discrepant data that really gave us more trouble last summer, more anxiety, than almost any other circumstance in connection with this project. It invested everything with the air of uncertainty—too much versatility about it. We would have preferred to have some concrete statement which would be consistent right through with the company's other data.

Mr. DOOLITTLE. Do you consider it inconsistent to have obsolete plans on hand where a work of this kind has been carried on?

Colonel LUDLOW. Not the least in the world. Still, I say we have never been able to understand the indication of that ledge of rock.

Mr. DOOLITTLE. You say that it is obsolete and does not appear in the present plans for the construction of the dam, does it?

Colonel LUDLOW. The statement exists in print yet.

Mr. DOOLITTLE. I suppose the entire history of the human race exists.

The CHAIRMAN. The importance of that is the fact that it is the assertion of a rock foundation.

Colonel LUDLOW. It is the declaration to the eye of a rock foundation which does not exist, and for which at the time it was made there was no authority at all. Subsequent to the making of that profile borings were made, which, so far as they were made, disproved it entirely. But that didn't prevent the statement being made in the official paper of 1893, that clay, gravel, and rock were found there in the order named. That statement was distinctly made as late as 1893. Those "inadvertencies" therefore become serious.

Mr. DOOLITTLE. From the great mass of data gathered from time to time, and which the company had at their office in New York, it would not be strange, would it, that data that had been demonstrated to be irregularly constituted or not absolutely reliable should creep in and be published with the mass of publication?

Colonel LUDLOW. It seems to have been done.

Mr. DOOLITTLE. Don't you think this would be the natural and probable thing?

Colonel LUDLOW. From one point of view. But, understand, the publications I am noting are not what might be called popular and commercial publications, but specific and technical statements of the chief engineer of the company.

Mr. DOOLITTLE. For instance, I know of my own knowledge that in the newspapers statements are made based on and relating to old data and plans, published as carrying out the present ideas of the company, being totally at variance with the company's plans at this time.

Colonel LUDLOW. Yes, no doubt. I quote from page 27 of Mr. Menocal's formal paper prepared for the Columbian Water Commerce Congress. This is under the head of excavation, etc.:

At the site of the Ochoa Dam gravel, clay, and rock, in the order named, are shown by the borings.

And the date of this paper is 1893.

I assure you, gentlemen, that this task of mine is not an agreeable one. But there was no recourse but to do what we had to do and work it out to the finish. I do not know that there is anything else at this moment. There is so much of it—all this testimony we have here bristles with points that could be picked up, more or less, and absurdities shown. This question of hydraulic data, which is one of the most serious points of criticism that the Board has had to find with the company's project, is one which I should perhaps refer to briefly. In the company's records there is an apparent absolute lack of hydraulic data of rainfalls, of the rise and fall of streams, of the volume of streams, showing high-water marks, etc.

These forces are perhaps more formidable here than at any other point on the face of the earth, without any exception, and the information in regard to it is almost entirely lacking, when it could have been had just as well as not if the importance of it—its absolute vital necessity from an engineering standpoint—had been understood. Mr. Menocal, in his paper, which forms a portion of his testimony, admits the deficiency in

the hydraulic data, but seriously contends that, after all, the gathering of it would be of no practical value, for the reason that it takes prolonged periods of years to get maxima and minima results; that even after twenty years of investigation the phenomena of the twenty-first year would likely upset all averages; for which reason, apparently, it has been concluded not to get any information at all—because at the twenty-first or thirty-first or forty-first year all your labor would have been done in vain, on account of some extraordinary condition of things. We contend, you know, that this is an absolutely unsound view—that it is not engineering.

Furthermore, Mr. Menocal condemns the Nicaragua Canal board for insisting upon the necessity for certain surveys. We have said why we wanted them. We want the hydraulic data, we want a survey of the San Juan River, and we want a lot of things which we could not get from the company, and upon which we could get no information. We wanted the regimen of the lake, and wanted to investigate the discharge of the river, and so on, a computation of the rainfalls, particularly in the San Francisco Basin, and in all that proposed construction where the work is of great magnitude and where the tremendous rainfall is a matter of serious consideration. We wanted all that. Mr. Menocal declared at one point in his testimony that all this would be a mere waste of time. At other points in his testimony it appears that at the time operations were suspended down there the company had seriously proposed an entire, clear, thorough survey of the San Juan River from Ochoa to the lake, which they had kept in view, and which they had only deferred in view of what was more important; and the termination of their labors down there found the work undone.

Mr. DOOLITTLE. The substance of Mr. Menocal's statement in regard to the rise and fall of the lakes was this, was it not, that during the construction of this canal all of these matters could be ascertained, as well as the details, in a great work of this character; that whatever was necessary to be done might then be performed in the carrying on of the work, and making the surveys after the matter was taken up in earnest?

Colonel LUDLOW. You would not even build a stable that way; you would not build a house that way.

Mr. DOOLITTLE. Isn't that the substance of Mr. Menocal's statement?

Colonel LUDLOW. Yes, sir, I think so; I quite agree with you, and it is the most extraordinary substance I know of in connection with engineering matters—that the engineering work is to be done after the construction has been commenced.

Mr. DOOLITTLE. You stated the other day that after the work had been commenced many matters could be ascertained and details arranged, and all that sort of thing.

Colonel LUDLOW. Yes, but look at this, Mr. Doolittle. See how absolutely vital this is—for the regulation of this summit level, and the determination of what that should be, you must have these hydraulic data.

Mr. DOOLITTLE. Again, right there. The maintenance of this summit level is insured by the building of the dam at Ochoa.

Colonel LUDLOW. The chief engineer says not.

Mr. DOOLITTLE. Isn't that true?

Colonel LUDLOW. He says not.

Mr. DOOLITTLE. I ask you.

Colonel LUDLOW. No; I say not, too. I agree with him on that point.

Mr. DOOLITTLE. If a dam were built sufficiently high at Ochoa it would keep the lake up to 110 feet?

Colonel LUDLOW. You can do it.

Mr. DOOLITTLE. Now, then, if the flow of water is so great as to increase that height of the level somewhat, that excess of water then is carried off by the weirs, is it not? Isn't that the plan?

Colonel LUDLOW. I suppose so.

Mr. DOOLITTLE. As rapidly as it descends?

Colonel LUDLOW. No, you can not do it as rapidly, because there must be a slope in the river in order to discharge the lake.

Mr. DOOLITTLE. Certainly, and the rise in the lake would make a fall.

Colonel LUDLOW. The lake piles up and makes its fall. To what height is that lake going?

Mr. DOOLITTLE. Suppose it is 110 and then goes to 117.

Colonel LUDLOW. Seven feet higher?

Mr. DOOLITTLE. Yes, sir, or 112 or 113. Then it is discharged and the lake falls back to 110.

Colonel LUDLOW. On those subjects our information is almost entirely lacking. The only authentic information we have on this subject is what we obtained ourselves.

Mr. DOOLITTLE. I have not been there and I am not an engineer, but that would be the result, it seems to me.

Colonel LUDLOW. The range of that lake always seems to have been assumed by the company. It is variously stated at 3, 5, and 7 feet; and recently, since the publication of our report, it has been put up to 10 feet, for the first time, in the canal literature. We found evidence, and had reason to believe, that the lake varies from maximum to minimum through a range of 14 feet—certainly 12 feet.

Mr. DOOLITTLE. That was taking into consideration the evaporation and all that?

Colonel LUDLOW. No; watermarks.

Mr. DOOLITTLE. I say it necessarily embraced that.

Colonel LUDLOW. It included all the physics, certainly. We asked the question. If we fix the summit level at 110 feet, how much is the lake going to rise above that? If you can not regulate it within limits you are going to submerge an enormous amount of valuable land. The engineer has to look into those things. The city of Granada would be invaded.

Mr. DOOLITTLE. Contingencies of that kind are embraced fully in the concessions, are they not?

Colonel LUDLOW. Oh, no; there is no concession permitting the drowning out of private property without compensation. If there were, it could not be done. Furthermore, if the committee will bear with me a moment, you do not understand how we worked over that problem. It is absolutely vital. The dam is supposed to effect the regulation. We met a statement from the chief engineer that the high lake level is to be regulated by the Ochoa Dam. You can not do that. It is a fixed dam; there will be no gates on it. Furthermore, we have a letter from the chief engineer, which we received last summer, in which, in answer to a question on that point, he replies that the lake level is to be regulated by discharging 60 per cent of the surplus drainage of the lakes westward through the canal into the Pacific. At one place it is to be regulated by the Ochoa Dam. How, I don't know, because there is no provision there for anything movable, and the lake and river are oscillating up and down. You can not regulate anything by a fixed quantity. Then comes the extraordinary statement that no less than 60 per cent of the total waste or surplus drainage is to be carried off to the westward through the Pacific canal. Those state-

ments can not be reconciled; they are incoherent; it is not engineering.

Mr. JOY. If the lake rises at its highest point 120 feet 10 feet above the summit level, would it not submerge just as much land as if the dam raises it 110 feet?

Colonel LUDLOW. The lake never goes there now. The highest we have noted was but 111 or 112 feet.

Mr. JOY. You say there was a range of 14 feet?

Colonel LUDLOW. Between the minimum and maximum stage, the maximum being represented by 112 feet above sea level at present in the natural conditions as we found them there. Now, you put your dam up so it shall not fall below 110 feet. You only have a range of 2 feet to the present maximum stage, but the water between its highest and lowest range has still to be accounted for, and if you refuse to let the lake fall below 110 feet, you have to allow for the entire maximum range above that during rainy seasons.

Mr. DOOLITTLE. And for the disposal of that water?

Colonel LUDLOW. You have to get rid of it some way or it will drown out the valley.

That is a series of questions the company had not investigated. We could not get any information on the subject from the company. When we went around the lake and through the river we got watermarks ourselves.

Mr. DOOLITTLE. Do not the weirs prove that those things were taken into consideration?

Colonel LUDLOW. No; the weirs simply provide for a flow of water. They do not provide for regulating the lake level at all. You can not do that with fixed weirs at all. All you can be sure of with a weir is to hold water up to a certain point. We believe the weirs as proposed by the company will be totally inadequate during the descending stage of the lake—the dry season. They can not hold the water, we believe, up to 110 feet. The discharge over the Ochoa Dam is at 106, 105 is the sill of the weir at Ochoa, and the San Carlos weirs are a foot and a half lower than that, so that as the lake fell and the supply drained off it, it is unquestionable that the slope would become nearly horizontal and the river would drain itself down, not to 106 or 108, but to 103½, which is the reference of the weir sills on the San Carlos.

That is one of the lowest points, and if you don't keep water running in all the time there it will run down, naturally. It is those things we want light upon and which are indispensable to any real solid engineering project. No engineer would permit you to state that these data, that this information can be omitted, or that it would be safe to undertake the construction of enormous works until you have those data. How are you going to tell about the depth at which that great cut through the east divide shall be projected? A difference of a foot or two with an enormous chasm in a mountain range is a serious consideration, if you will figure it out. A difference of a foot! Of what number of feet? We want to know those things. We want to know the range and volume of San Juan River and the bed of it, and what material, and of what nature and kind and quantity it is, to be removed from there to make a channel. We want to know about the means of transit and transportation lines, which the company has not ascertained. They worked like beavers there and accomplished a great deal; but in spite of their hard work there is an uncertainty of 1 foot of level between Ochoa and Greytown, which at the conclusion of its work the company had sought to discover by a thorough-going double check line of levels

from Greytown to the divide and thence to Ochoa. That showed what they thought about it, although we have no reference to that, you understand, in the printed information.

I do not know, gentlemen, that it is expedient to go on further with these general points. We have believed it in the interest of American engineers, if you choose, that this project should be put in such shape and be treated in such a rational sense that it would be accepted by the engineering world outside of us. You can not do these things under a bushel. This is a project that excites the interest of the whole engineering world. It is the most interesting engineering work ever started, and the difficulties of the work are not exceeded by any other such work.

Mr. BENNETT. Still, there are no difficulties so serious in this work that they can not be overcome?

Colonel LUDLOW. You will never get an engineer to admit that there are difficulties which can not be overcome; that any engineering project not inconsistent with the laws of nature is impossible if you have money and time enough to accomplish it.

Mr. DOOLITTLE. The difficulties here are not insurmountable, according to your own judgment as a man?

Colonel LUDLOW. No, sir. The board has expressed the opinion that it is convinced of the fact that the construction of a canal across the isthmus is feasible. We have said so, and we believe it; but not, if you please, with this kind of engineering, because you can start to build a canal there, if you choose, gentlemen, and you can spend, as I said, a thousand million dollars, and not get through. The French engineers tried that. They spent $500,000,000—that amount, at least, has disappeared—and they have nearly wrecked the French nation on account of it.

Mr. DOOLITTLE. You can do that with nearly any undertaking.

Mr. BENNETT. How much it cost is absolutely unsettled.

Colonel LUDLOW. We believe, after the most faithful consideration we can give this subject, the cost of work and labor, and what it will be necessary to do, etc., the cost of construction, actual construction, nothing else, will be under $135,000,000. I expressed the opinion the other day, in response to an inquiry, that I regretted we had not made the estimate $150,000,000, because I thought that sum would be safer. It is a matter of judgment. We are perfectly convinced that the canal can be built.

Mr. DOOLITTLE. Within the limits you name in your report?

Colonel LUDLOW. Yes, sir; we believe it can be done, and so state. But we do not believe at the present time there is sufficient information to warrant the formulation of the engineering project, with the details of construction, giving it out to the world and advertising for construction, which is the only way it can be built. It is to be advertised to the world and to be bid for by the contractors of the world. It will have to be divided up into sections for construction and the contractors must have a chance to bid so and so on each section. How are you going to do all that on the information that is available at the present time? An engineer or a contractor will tell you it can't be done; they will not go ahead on it. You couldn't make a contract with them to build the canal on the information we have.

Mr. BARTLETT. The substance of your view as to construction is that it can not actually be commenced until a resurvey is made?

Colonel LUDLOW. It can be.

Mr. BARTLETT. With safety?

Colonel LUDLOW. From the engineering standpoint, I think it is extremely dangerous to do. It is what has gotten people into trouble whenever they have undertaken it. You see, the engineer is stubborn about that; he wants to know what he has to do before he undertakes to do it. He doesn't want to postpone accumulating his data, which will settle costly things, until he gets it nearly done. I assure you there is not an engineer in the world who would not tell you the same thing, if you sent for the whole of them.

I have a lot of data here, in accordance with your request, that we spent yesterday in going over carefully. We have collected a lot of stuff which was really the guide for us in making the prices in our report.

Mr. DOOLITTLE. You may state again, Colonel Ludlow, who is the chairman of the Board of Commissioners who visited Nicaragua.

Colonel LUDLOW. My colleagues on the board were good enough to elect me to that position.

Mr. DOOLITTLE. And who was the secretary?

Colonel LUDLOW. We had some trouble in getting a man. We first got a man from the War Department, and he was scared off; and then I had another one engaged, and he went off.

Mr. DOOLITTLE. Whom did you finally get?

Colonel LUDLOW. A man named Stoddart.

Mr. DOOLITTLE. Was he present with you in New York at the time this report was made up and the items considered?

Colonel LUDLOW. Yes; he was there right along. He was the typewriter and stenographer for the Commission. We called him the secretary because it sounded a little more dignified.

Mr. DOOLITTLE. Now, when all of the items embraced in this work were being considered by the board, did the board regularly vote upon the questions arising as to quantities, etc.?

Colonel LUDLOW. No, sir; we never voted on anything. We were together all day long, and conferred all the time. We didn't have any formal voting.

Mr. DOOLITTLE. In conceiving the spirit of your report, how was it that you decided to enter into a critical discussion of the project of the company's chief engineer instead of confining yourselves to a simple, straightforward report, making, as competent engineers, your own project from the data furnished or obtainable?

Colonel LUDLOW. There are two answers to that. One is that the reports of the chief engineer constituted the basis of the company's project—I do not know of any other. The second answer is that the law enacted by Congress under which the board was operating specifically directed our attention to the company's project, and did not authorize us to propose a project of our own. That appears on the inside of the cover of our report. We quote the law there, and with your permission I will answer your question that way, by direct reference to the law—an extract from the act approved March 2, 1895. I may say here that we were pleased to find that we were not expected to formulate a project of our own, but that under the provisions of that act we were directed to look into the feasibility of constructing the canal by the route already contemplated, or, to quote the language of the law—

For the purpose of ascertaining the feasibility, permanence, and cost of the construction and completion of the Nicaragua Canal by the route contemplated and provided for by an act which passed the Senate January twenty-eighth, eighteen hundred and ninety-five, entitled "An act to amend the act entitled 'An act to incor-

porate the Maritime Canal Company of Nicaragua,' approved February twentieth, eighteen hundred and eighty-nine," twenty thousand dollars.

That's what we went to investigate. How are you going to separate the chief engineer's statement from the project of the company. It is his project. He is the author of the project; who else? Engineers make engineering projects. The chief engineer of the canal company—or whatever the association is called—naturally made the project. It is a part of the official record of the company. Mr. Menocal's official report of 1890 stands on record as the last publication from the company as explaining the project, and we had that in our hands. We had that to steer by.

Mr. DOOLITTLE. Now, this report was made up from the data furnished by the company?

Colonel LUDLOW. Our report?

Mr. DOOLITTLE. Yes, sir; in the main, was it not?

Colonel LUDLOW. But in our report you will find many statements and assertions based on information we gathered ourselves.

Mr. DOOLITTLE. Your report, however, was most largely made from the company's data?

Colonel LUDLOW. The details, yes, sir; but the important vital data we endeavored to ascertain for ourselves.

Mr. DOOLITTLE. Why did you not yourselves get the data you complain the company did not furnish?

Colonel LUDLOW. Instead of six months and $20,000, it probably would have taken three years and $600,000 to have done that.

Mr. DOOLITTLE. Do you think it would take three years to obtain the data that the company's statements are deficient in?

Colonel LUDLOW. We estimated that it would take two and a half years, and we made a very narrow estimate—I should say we estimated it would take a year and a half, and I am sorry we did not make it two years.

Mr. DOOLITTLE. Now, I wish you would state to the committee what examination you made when traveling up and down the San Juan River to ascertain the character of the material in the bottom of the stream.

Colonel LUDLOW. We had no opportunity to make any.

Mr. DOOLITTLE. Isn't it true, according to modern methods of ascertaining the character of the bed of a river, that had you used the water-jet rod the character of the bed of the San Juan River could have been ascertained so far as earth material was concerned?

Colonel LUDLOW. No; excuse me, but there are two things that you embrace. You speak of a rod and a jet. One means a jet of water through a pipe. That is the forcing power of the jet which you depend on to sink a pipe down. In the other case, you have a solid rod.

Mr. DOOLITTLE. I understand, but isn't it termed by engineers and contractors water-jet rodding?

Colonel LUDLOW. I have never heard it.

Mr. DOOLITTLE. I have a good many times, and I am not very familiar with engineering work.

Colonel LUDLOW. Those terms vary in different parts of the country.

Mr. DOOLITTLE. How much expense would have been involved in making that kind of a test from the steamer that conveyed you up and down the river—that is, so as to satisfy yourselves in a general way?

Colonel LUDLOW. We could not do anything of the kind. There were 30 miles of it. We would have had to spend the whole time trying to find out that bottom, and you can not get a water jet into a rock or hard clay.

Mr. DOOLITTLE. But you can through earth material?

Colonel LUDLOW. What is earth?

Mr. DOOLITTLE. Earth material—clay.

Colonel LUDLOW. The jet would find great difficulty in penetrating some clay.

Mr. DOOLITTLE. Is it not true that in building the Port Orchard dry dock they were enabled to penetrate the very hardest kind of cement hardpan by this means?

Colonel LUDLOW. Oh, yes, it is quite possible, because hydraulic mining will tear almost anything. I have seen great chimneys torn down by this power.

Mr. DOOLITTLE. This is not hydraulic mining, but a water jet.

Colonel LUDLOW. We had no appliances of that kind at all. It was out of the question for us to make such an examination. Our time was too valuable to do that.

Mr. DOOLITTLE. What would have been the expense of sending a man to have made an examination of that kind?

Colonel LUDLOW. What, 30 miles?

Mr. DOOLITTLE. Yes, at frequent intervals through these 30 miles, making examinations.

Colonel LUDLOW. The material varies everywhere, according to the company's information, from sand to rock. You can go down with a water jet in sand. We could work through the clay, perhaps. We would not get far into the gravel. The jet distributes itself against the gravel, and you can not easily penetrate. With the rock, of course, we would be perfectly helpless. If we struck a bowlder, we would not know what it was. For such work steam drills, diamond drills, are necessary.

Mr. DOOLITTLE. You are familiar with that method. Could you state to the committee the expense of an investigation of that kind, to be made by a competent man?

Colonel LUDLOW. It would have taken all our time down there.

Mr. DOOLITTLE. But you had other men with you?

Colonel LUDLOW. Yes; and we kept them busy.

Mr. DOOLITTLE. You did not detail anyone for that?

Colonel LUDLOW. No; no more than we detailed men for boring through the east divide.

Mr. DOOLITTLE. Didn't it occur to you that so far as the clay and sand in the bottom of the river was concerned, it should be investigated?

Colonel LUDLOW. We were decidedly of that opinion.

Mr. DOOLITTLE. Still you did not make such investigation?

Colonel LUDLOW. Not in the least. We thought that borings should be made in the east divide also, but we did not do so.

Mr. DOOLITTLE. Will you state that an investigation could not have been made for $500 or $600 that would have enabled competent local parties to have water-jet rodded the whole bed with thousands of holes from that steamer?

Colonel LUDLOW. It was not possible.

Mr. DOOLITTLE. That is, so far as the earth bottom of the river is concerned?

Colonel LUDLOW. Oh, that could not be done.

Mr. DOOLITTLE. And within the period you were down there?

Colonel LUDLOW. You think that for $400 or $500 you could get an engineer to make an investigation and ascertain the material which constituted the bed of that river. You could not do anything of the kind.

It would take many months instead of days or weeks, and thousands instead of hundreds of dollars.

Mr. DOOLITTLE. My suggestion is simply this: That by the use of a water jet, rod, or tube, used from the steamer that you were traveling on, you could have made an investigation. It is true, isn't it, that in sand a water-jet pipe will descend as rapidly as you can drop it down?

Colonel LUDLOW. Sometimes faster.

Mr. DOOLITTLE. And isn't it true that that kind of an investigation, for the purpose of ascertaining in a general way the bed of this stream for the purpose of your report, could have been made at an expense of $500 or $600?

Colonel LUDLOW. I don't think it could. It would simply be a waste of $500 or $600. Furthermore, the company had in its own possession a profile which purported to show the nature of that river bottom. We didn't find out that that profile was utterly fallacious until afterwards.

Mr. DOOLITTLE. When did you find it was utterly fallacious?

Colonel LUDLOW. When we came to examine the company's records in New York. We found then that that profile was directly taken from the Lull information; and when we came to find out what information the Lull expedition obtained in reference to the river we found that they had simply made a boat survey of the river, taking the indications of the lead. We had no reason to distrust the authenticity of the information given us by the company until we found that there was no foundation for it, or next to none. The information was based merely on surface indications, the leadsman calling out what the indications were as the boat went along. But there is a carefully constructed profile, which is a part of the company's records, and which was given to us as a basis of their estimates.

Mr. DOOLITTLE. Will you not state what you did, if anything, while down there in the way of ascertaining what the bed of that river actually contains in the way of material?

Colonel LUDLOW. We made no further attempt to ascertain the character of the bottom of the river than the noting of what we could see.

Mr. DOOLITTLE. What did you see that led you to believe that there was rock there?

Colonel LUDLOW. We saw lots of rock there.

Mr. DOOLITTLE. What was the character of the rock; bowlders or ledges?

Colonel LUDLOW. Ledges and bowlders, both.

Mr. DOOLITTLE. Where did you observe along the line of the river this rock you speak of, and to what extent?

Colonel LUDLOW. At all the rapids.

Mr. DOOLITTLE. Won't you specify at what points?

Colonel LUDLOW. At Machuca; above that the Balas Rapids; the Castillio Rapids; at the Toro Rapids above that. At all of these points there was a large rock exposure. The river was low when we were there.

Mr. DOOLITTLE. What extent would you say this rock covered between Ochoa and the lake, from your observations?

Colonel LUDLOW. What we could see?

Mr. DOOLITTLE. Yes, sir; what you were able to note.

Colonel LUDLOW. It was a matter that could be measured by a few miles—what we could see. At the Machuca Rapids, I think, about 2 miles or 2¼ miles; at the Castillio Rapids only about a quarter of a mile; at the Balas Rapids the rock covered perhaps 2 or 3 miles; at the Toro Rapids it would cover perhaps 2 or 3 miles.

Mr. DOOLITTLE. Altogether, not to exceed 8 miles?

Colonel LUDLOW. That much in sight.

Mr. DOOLITTLE. And not to exceed that much rock in sight?

Colonel LUDLOW. That is perhaps all we saw.

Mr. DOOLITTLE. Then you don't know that there is any other rock there than that you have mentioned?

Colonel LUDLOW. No. Our information was derived from the profiles submitted by the company. It was given us as official and was our information.

Mr. DOOLITTLE. The other day when you were making a statement about the terminus of the canal on the Atlantic side, you said you thought it wise to change the mouth of the canal. In other words, when you recommend a different Greytown entrance, do you not know that the point you designate is forbidden by the concessions—forbidden by the charter of the company?

Colonel LUDLOW. No; we didn't pay much attention to that point—what was provided for by the concessions or the charter. We were doing engineering.

Mr. DOOLITTLE. Didn't you know that you crossed the boundary line?

Colonel LUDLOW. Yes; we knew it crossed the alleged boundary between Costa Rica and Nicaragua.

Mr. DOOLITTLE. Had you looked at the concessions to see whether it could be changed within the limits of those concessions?

Colonel LUDLOW. No, sir; we did not concern ourselves with those things.

Mr. DOOLITTLE. Now, if that could not be changed under those concessions, would you still adhere to your plans?

Colonel LUDLOW. I do not believe in paralyzing a project of this kind by a mere question of a mile or two of sand beach.

Mr. DOOLITTLE. But you did state that the Greytown Harbor could be constructed; that it was feasible?

Colonel LUDLOW. We think so.

Mr. DOOLITTLE. In accordance with the plans of the company——

Colonel LUDLOW. The plans of the company? Not in the least. We believe that to be impracticable.

Mr. DOOLITTLE. You believe it to be impossible?

Colonel LUDLOW. Oh, what is impossible? I would say impracticable—out of the question, if you choose, both as a question of engineering and cost.

Mr. DOOLITTLE. You believe a channel sufficiently deep could be constructed there by carrying those jetties sufficiently far seaward? If those jetties were built out far enough it could be maintained, you think, do you not?

Colonel LUDLOW. It would be a fearful cost, and presently it would be threatened with destruction.

Mr. DOOLITTLE. Please state what fearful cost?

Colonel LUDLOW. As fully set forth in our report. And I assure you, gentlemen, we gave most careful consideration to that whole subject. We surveyed it and examined it and walked the beach and went up to investigate the Indio and Harbor Head, and had a whole survey of it made. We do not believe the Greytown Harbor entrance can be built where the company proposes it; that is to say, we regard it as impracticable, for the reason it is the head of a bight, and we believe that the sand movement there—it being in both directions—is such that if you undertake to make your entrance there you will have to

fight the sands coming from the east and from the north, and fight them forever.

Mr. DOOLITTLE. What did you observe there, Colonel Ludlow, that led you to this conclusion?

Colonel LUDLOW. That the sands were coming from both ways.

Mr. DOOLITTLE. How did you know?

Colonel LUDLOW. We saw them. There is no question whatever about that.

Mr. DOOLITTLE. Sands washing down the coast?

Colonel LUDLOW. Washing westward from the Harbor Point—from that broken piece off there [indicating on map], which is called Harbor Head. It looks like a little harbor or reentrant to the land at the right of that red thing [indicating on map], which represents the canal harbor. To the right of that there is an opening, which from time to time is the harbor and the entrance to Greytown, and the only one. That was the case when the company went there. Now, the sands unquestionably are coming in from that point of land.

Mr. DOOLITTLE. Is that point of land threatened by this wash?

Colonel LUDLOW. Yes, sir. It is being cut off at the end. We discovered that; it had never been noted before. We made a careful comparison of a series of maps showing that point, and we proved that that eastern end was wasting.

Mr. DOOLITTLE. And that bight was being filled up?

Colonel LUDLOW. Filled up in that direction. It can not be otherwise, because, if you please, if you lay off a line there bearing between east and northeast you will get the direction of the prevailing wind, with an average direction of about east-northeast. That is the average direction of the trade winds. You will see, the east-northeast trade strikes the beach at an angle of about 45°. Those waves come in at that angle. They gather up material and take it along. The next wave takes it farther. You can see it; you can throw a chip over and see it.

I know of a war ship that was anchored off that entrance, within a mile, and the sands there are so easily moved that the ship's anchors would not hold. They originally anchored off about 4 miles. They thought it would be more convenient to come in nearer, and so they came within about a mile of the beach. Their anchors held offshore, but after they came in this distance their anchors did not hold, but dragged, and they had to go out again. That, if you please, Mr. Doolittle, is half of it.

Now, I will explain what the board believe to be the fact in regard to the other portion. There is that river Indio. In approaching the beach it turns parallel with the shore, toward Greytown. If I had a pointer I could indicate on the map what I mean. I mean the Indio comes down near the beach, and instead of directly entering the Caribbean Sea follows parallel on the inside. We investigated the action of that river there, and from the best information we could get its normal discharge was out into the Caribbean Sea, as would naturally be the case, but it has constantly worked to the south [indicating on the map], meeting the sea farther and farther to the south, and that sand spit follows along after the entrance until it gets near to Greytown.

Mr. DOOLITTLE. What distance?

Colonel LUDLOW. I think it has been within 2 or 3 miles, and this upper distance here is a matter of 10 miles where it might go out; and from time to time, with a strong freshet from the Indio, the stream will cut right through that narrow stretch to the sea. Suppose that river

takes a notion to go straight out there, it has left then all that body of sand spit between its present mouth and Greytown. It has sort of transferred that sand spit bodily to the right bank, when it was formerly on the left. It goes on and does that thing again. It repeats itself, and, as we believe, although no observations have been made, that action is continually going on, with the result that there is a bodily movement of that beach sand down toward the end of this funnel, meeting the incoming sand from the other side. We do not believe it to be safe to undertake to build an entrance to that harbor there.

Mr. DOOLITTLE. What is the size of that river?

Colonel LUDLOW. A great big river.

Mr. DOOLITTLE. It does not compare with the San Juan?

Colonel LUDLOW. We did not go up the Indio very much. I should say where we saw it, near the entrance, I presume it was 200 to 400 feet wide and above that wider.

Mr. DOOLITTLE. Is that affected by the tide?

Colonel LUDLOW. There is no tide in the Caribbean Sea to speak of.

Mr. DOOLITTLE. Is there a tide at Greytown? What is the tide there?

Colonel LUDLOW. From 9 to 13 or 14 inches.

Mr. DOOLITTLE. Is that a silt-carrying stream?

Colonel LUDLOW. All those streams have been, I think, in times past, because this delta is built up of that.

Mr. DOOLITTLE. Did you examine that stream?

Colonel LUDLOW. Walked up the beach ourselves; yes, sir.

Mr. DOOLITTLE. Now, what would that have had to do with the depth of water to be obtained between those jetties, provided those jetties were constructed of proper material and carried out to a sufficient depth to deep water—permanent deep water?

Colonel LUDLOW. How far would it go?

Mr. DOOLITTLE. How far would you go?

Colonel LUDLOW. That is the point.

Mr. DOOLITTLE. How far do you go out there to get 7 fathoms of water?

Colonel LUDLOW. About 6,000 or 8,000 feet.

Mr. DOOLITTLE. That is not a very long jetty, is it?

Colonel LUDLOW. The 7-fathoms contour is about 4,000 feet from the shore, and the 8-fathoms contour about 8,000 feet from the shore, on the line of the company's jetty. They built a thousand feet of it, or less, and the shore line has followed out as they built the pier.

Mr. DOOLITTLE. That is not a jetty of unusual length at all—8,000 feet—is it?

Colonel LUDLOW. No, there are jetties much longer than that.

Mr. DOOLITTLE. Yes, even at the mouth of the Columbia River; twice that length.

Colonel LUDLOW. Perhaps two or three times as long.

Mr. DOOLITTLE. The one contemplated at Greys Harbor, the coast of Washington, for instance.

Colonel LUDLOW. Yes, sir; the breakwater at Chicago is 6,000 feet.

Mr. DOOLITTLE. Then the building of jetties of that length would be, of course, nothing unusual?

Colonel LUDLOW. No, not if it were necessary. But suppose you had reason to apprehend that after you had built your jetties, in the course of a period of time not extremely protracted, your work would be wasted?

Mr. DOOLITTLE. How far beyond the point of land that is being cut *down would* they reach if carried to 8,000 feet?

Colonel LUDLOW. You see how that jetty heads [pointing to map]?

Mr. DOOLITTLE. Yes, sir.

Colonel LUDLOW. Up the beach.

Mr. DOOLITTLE. I do not regard it as up the beach.

Colonel LUDLOW. It heads north, a little west of north.

Mr. DOOLITTLE. How far would 8,000 feet carry it?

Mr. NOBLE. Very nearly north.

Mr. DOOLITTLE. The head of land you spoke of. Would not 8,000 feet, or if carried out to 7 fathoms, would it not be away out seaward, beyond the point of land you have been speaking of as being cut away?

Colonel LUDLOW. It would be farther from shore, but not in deep water.

Mr. DOOLITTLE. Would it not be in deeper water?

Colonel LUDLOW. No; because you can get at a point farther east 8 fathoms in a very short distance.

Mr. DOOLITTLE. How far would you go before you would get 8 fathoms of water?

Colonel LUDLOW. Two thousand feet from shore.

Mr. DOOLITTLE. How far does that point of land extend northward beyond the mouth of the canal, emptying into the sea?

Colonel LUDLOW. How far does that extend northward? It does not extend northward.

Mr. DOOLITTLE. In what direction does it extend?

Colonel LUDLOW. The point of land you speak of is about east of the canal.

Mr. DOOLITTLE. I understand, but I say how much farther north does it extend than the mouth of the canal as shown on the map?

Colonel LUDLOW. I don't think it is any north of it.

Mr. DOOLITTLE. Then does it extend farther seaward to the north compared with the mouth of the canal?

Colonel LUDLOW. Farther seaward—farther eastward.

Mr. DOOLITTLE. And farther north?

Colonel LUDLOW. I think not.

Mr. DOOLITTLE. See, the arrow points north, doesn't it [pointing to map]?

Colonel LUDLOW. Yes; it is supposed to. That is a very crude map. I brought down with me the only little map I could find of this thing.

Mr. DOOLITTLE. In accordance with this arrow, this point of land here——

Colonel LUDLOW. Seems to lie a little northerly, I see. It seems to.

Mr. DOOLITTLE. I say, how much farther north does it lie than that harbor [referring to map on the wall]?

Colonel LUDLOW. I don't know. You can not estimate anything off that.

Mr. DOOLITTLE. You ran surveys?

Colonel LUDLOW. Surely; but if you will give me a map I will show you in a minute. We turned in six or eight maps of Greytown Harbor. I may be permitted to state, while I am about it, that there have been very capable engineers who have declared the construction of a harbor at that point impossible.

Mr. DOOLITTLE. I wish you would name those engineers.

Colonel LUDLOW. I do not know, at this moment, who they are. I merely state that fact. We do not quote them, because we do not agree with them.

Mr. DOOLITTLE. You believe a harbor can be built there?

Colonel LUDLOW. Yes, and say so, and estimate for the construction.

This little map I have here is the best I happen to have with me, but it does not show very much; it is on too large a scale. I might say that point seems to be a little north, if you please.

Mr. DOOLITTLE. I would like to ask you whether, in your judgment, it would be a better plan to extend those jetties in a right line and to the north than to construct them as they are constructed in accordance with the plans of the company?

Colonel LUDLOW. We think, as far as that jetty is concerned, it is sufficiently well placed, and about the proper direction, supposing you are going to make your entrance at that point. We do not criticise that.

Mr. DOOLITTLE. How far out beyond the 8,000 feet would it be necessary, or have you any data to base your judgment on, as to how much farther out those jetties should be built than 8,000 feet in order to get them into permanent deep water?

Colonel LUDLOW. If you got out to 8,000 feet you have got into a depth of water which we found by examination of the charts—the information was not entirely full about it—the indications were that the 8-fathom contour in the sea bed was quite fixed. There seemed to be a remarkable stability about the 8-fathom curve.

Mr. DOOLITTLE. And you think the sand would no longer trouble when you reached the 8-fathom depth?

Colonel LUDLOW. It did seem, under the ordinary natural conditions, that there had been very little movement of the sand at that depth.

Mr. DOOLITTLE. How far would you go beyond the 8,000 feet before reaching 8 fathoms?

Colonel LUDLOW. That is where you get it on the line of the company's pier.

Mr. DOOLITTLE. In 8,000 feet?

Colonel LUDLOW. You would get it at 8,000 feet on the line of the company's pier.

Mr. DOOLITTLE. You believe that would make a permanent harbor and channel?

Colonel LUDLOW. You asked me how long it would take to diminish the depth of the entrance at that point. Now, understand me, we believe that where this company's entrance is proposed the filling takes place from both directions, and with a pier constructed as the company proposes, the sand would bank up there—the sand coming from the east, as it will—with any jetty you put there. Furthermore, it is exposed to the influx of sand from the west, which has got to be taken care of.

Mr. DOOLITTLE. But if extended to 8,000 feet in length?

Colonel LUDLOW. If it were extended so as to inclose the whole thing on both sides it would be a long time before you would have any trouble with it.

Mr. DOOLITTLE. And a channel of that kind can always be dredged?

Colonel LUDLOW. Yes.

Mr. DOOLITTLE. I say it can always be readily dredged if it shallows.

Colonel LUDLOW. There is no serious trouble about that; it has to be done on pretty much all sandy shores.

Mr. DOOLITTLE. Your summary is that the canal is feasible, can be built and operated and maintained at a profit to the builders, and with advantage to the United States and the commerce of the world?

Colonel LUDLOW. I don't recognize that exactly as a quotation from our report.

Mr. DOOLITTLE. Isn't that your conclusion; isn't that true?

Colonel LUDLOW. I prefer the text of our conclusion as contained in our report. We confine ourselves to the engineering features

Mr. DOOLITTLE. But the substance of that is that the canal is feasible?

Colonel LUDLOW. We say it is feasible, and we think by modifying the company's project in some particulars it can be built.

Mr. DOOLITTLE. And can be operated and maintained at a profit to the builders, and with advantage to the United States and the commerce of the world?

Colonel LUDLOW. You don't find that in what we say. Do you want my personal opinion?

Mr. DOOLITTLE. Yes, sir.

Colonel LUDLOW. You asked me as a member of the board. We didn't go into any commercial statistics, any navigation statistics, or military statistics. That was not a part of what it was our business to investigate, and it would have been impertinent on our part to have done so. We were told to confine ourselves to engineering, and we were glad to do that.

Mr. DOOLITTLE. And you desire to answer that question by your report?

Colonel LUDLOW. We stand right on that; yes, sir. I am willing to express my individual opinion if it would be of any value.

Mr. DOOLITTLE. Now, isn't it true that your board believes that this country should be the prime factor, and that the canal would best be built with American talent, machinery, and supplies?

Colonel LUDLOW. That is a matter with which the Board, collectively, have nothing whatever to do; have never considered it. I can not speak for my colleagues on that matter.

Mr. DOOLITTLE. How is it with yourself? Do you believe this country should be the prime factor, and that it should be best built by American talent, machinery, and supplies?

Colonel LUDLOW. We expressed the opinion that it will have to be built by Jamaica negroes.

Mr. DOOLITTLE. I understand—that is, so far as the common labor is concerned, but I mean the general building?

Colonel LUDLOW. I think it would be an extremely nice thing for the American engineers to take a hand at this. The French engineers tried the Panama Canal and wrecked themselves. The English engineers had a chance at the Manchester Canal and blundered a bit—as the Englishman sometimes does—and the German had his chance at the Kiel Canal and made a success. Now, I want to see the American engineers take hold of this Nicaraguan Canal and succeed, as they will do.

Mr. DOOLITTLE. You have no doubt that they will succeed?

Colonel LUDLOW. Not the least.

Mr. DOOLITTLE. Do you not believe that Americans could build it quicker and cheaper than any others?

Colonel LUDLOW. I have absolute faith in the ability of the Americans to do almost anything better than anybody else, including the construction of canals.

Mr. DOOLITTLE. And in answer to this question you would unhesitatingly say yes?

Colonel LUDLOW. I should say so.

Mr. DOOLITTLE. Have you taken into the accounts on which your estimates are based the greatly lower prices of machinery, iron, steel, provisions, powder, and all the most modern methods for canal excavation, and utilization of electricity, compressed-air drills and pumps, and have you figured rail transportation per ton per mile according to results obtained?

Colonel LUDLOW. Oh, yes; we met the matter absolutely. We made an investigation of this in order to arrive at unit prices up to date—last summer. We resorted to every means of information open to us. We took in all the statistics we could get from responsible and reliable and capable people.

Mr. DOOLITTLE. Have you also considered that your estimates for this work are upon a gold basis?

Colonel LUDLOW. Oh, yes; we have not estimated anything except upon a gold basis.

Mr. DOOLITTLE. All a gold basis?

Colonel LUDLOW. We could not have made estimates upon a silver basis down there, because their silver is only worth 50 cents on the dollar, and it varies every day.

Mr. DOOLITTLE. What allowance did you make, if any, that labor, except skilled labor, would be paid for by silver in that country?

Colonel LUDLOW. We didn't go into that question. We depended in that respect largely upon information as to the actual value of all physical labor in the Tropics, getting our information from capable and well-informed men.

Mr. DOOLITTLE. You know that all unskilled labor there will be paid for in silver?

Colonel LUDLOW. Of course the natives there take silver. They never saw gold, and would not know what it was if you gave it to them. They would be paid in silver.

Mr. DOOLITTLE. You say you did not take that into consideration?

Colonel LUDLOW. We arrived at the matter by a shorter way. We left that consideration out because we found certain persons who knew all about that sort of thing. There was a concurrence of opinion that the actual value of labor was about one-half what it is in the United States. Consequently, the value being one-half, the cost would be doubled.

Mr. DOOLITTLE. What proportion of the cost of constructing this canal would the unskilled labor to be employed make up?

Colonel LUDLOW. I don't know; we didn't make any estimate on that.

Mr. DOOLITTLE. Could you readily do so?

Colonel LUDLOW. Not in the least, readily. It would be a difficult investigation, embracing a lot of figures. We would have to estimate the different kinds of work down there, as to what would be represented by skilled labor and what by unskilled labor, ordinary or brute labor. It would vary a great deal with the different kinds of work.

Mr. DOOLITTLE. Did you allow that any other items than labor would be affected by the use of silver in that country?

Colonel LUDLOW. We did not go into silver at all. We did not consider that question at all. We left that out. We were taking absolute prices, and all our estimates are based on the United States standard.

Mr. DOOLITTLE. As though the canal were being constructed in the United States?

Colonel LUDLOW. By American engineers and the use of American money, yes; and with the estimates based on American currency. There is no doubt about that. I think anybody who should estimate that would have to do it on that basis. Otherwise you would get yourself into fearful trouble if you should introduce the variable value of silver as a factor in your estimate.

The committee adjourned until 2 p. m.

AFTER RECESS.

STATEMENT OF COL. WILLIAM LUDLOW—Continued.

Colonel LUDLOW. Mr. Chairman, with your permission I will be glad to correct the record. I showed this profile of the Ochoa Dam this morning and stated it was one of the exhibits accompanying our report. I was in error as to that.

Mr. DOOLITTLE. On account of its being obsolete you made no use of it?

Colonel LUDLOW. Of course we had no use for it. It was submitted to us as all there was. We got nothing later, you understand.

Mr. DOOLITTLE. I wish you would state to the committee what proportion in relation to the expense does the unskilled labor bear to the total expense in works of this kind, and if you made any inquiry or attempted to inform yourself relative to that?

Colonel LUDLOW. That proportion will vary everywhere under different conditions, and particularly with the nature of the work to be done. There is much work that only skilled labor can do, and there is much work that unskilled labor can do—digging a trench, wheeling a barrow, etc.

Mr. DOOLITTLE. There will be a great need for unskilled labor in this work?

Colonel LUDLOW. There will undoubtedly be a large number of unskilled laborers employed in connection with it.

Mr. DOOLITTLE. And a very large proportion of the expense of constructing the canal would consist in the payment of this unskilled labor?

Colonel LUDLOW. Yes; of course they would have to be paid.

Mr. DOOLITTLE. But a large proportion of the total expense would be that paid out for unskilled labor?

Colonel LUDLOW. Yes, sir; I should say so; a large proportion.

Mr. DOOLITTLE. Can you make any general estimate relative to that proportion on this work?

Colonel LUDLOW. We have not endeavored to do so at all. I have not any data in my mind to enable me to answer that now.

Mr. DOOLITTLE. Would you say one-third of the total expense would be wages paid to unskilled labor?

Colonel LUDLOW. I should think that would be——

Mr. DOOLITTLE. Or half?

Colonel LUDLOW. It is a matter of estimate. I have not anything in my mind at the time to guide me.

Mr. DOOLITTLE. Have you had at any time during your investigation of this subject?

Colonel LUDLOW. No; that would be a thing I would have to study over.

Mr. DOOLITTLE. Have you had that in your mind at any time during the investigation of this subject?

Colonel LUDLOW. No; I think not.

Mr. DOOLITTLE. I wish you would compare for the committee the labor accomplished by the Jamaica negro paid in silver with the labor of this country paid in gold.

Colonel LUDLOW. I can only do that in one way. The Jamaica negro was very freely employed on the Panama Canal, and he was very freely employed on the construction of the Costa Rica Railroad. In both cases the two gentlemen whom we were able to get access to and who

were the best advised of the value of the labor on those two works were consulted, one being Colonel Rives, who for many years has been manager of the Panama Railway and fully cognizant of everything on the Isthmus, himself an engineer and railway man of extended experience at home and a very prolonged experience in that country; the other being Mr. M. C. Keith, an American, who built the Costa Rica Railway, a difficult work, built from Port Limon on the coast 104 miles to San Jose, the capital of Costa Rica, reaching an altitude of 5,000 feet. To his judgment in reference to the value of labor and to Colonel Rives' judgment in reference to the value of labor in that country we attach very great importance, and it largely guided our judgment. The statements of those two gentlemen were comparatively confirmed by similar estimates made in New York by contractors whom we recognized as competent and responsible men, and whose judgment seemed generally to confirm the concurrent judgment of those two men of whom I spoke. It all ran in the direction of showing that in order to estimate in this matter you can take the value of labor in the United States and multiply it by two.

Mr. DOOLITTLE. That is, the Jamaica negro would accomplish half as much in the same time as the laborer employed in the United States?

Colonel LUDLOW. No, not quite that; that the actual value of labor in the tropics, the actual value accomplished by the laborer in the tropics for a given quantity of work, would involve a cost twice as much as in the United States. It is not only inferior labor, but there are the climatic and health conditions as well.

Mr. DOOLITTLE. Have you any means of knowing what the experience of the Nicaragua Company was in the employment of this labor there?

Colonel LUDLOW. I am familiar with the fact, for example, that they did certain work.

Mr. DOOLITTLE. But about the successful employment of these men and their accomplishment compared with the labor of other countries?

Colonel LUDLOW. They built a railroad down there. There was some minor railroad work done by the company, and they had a certain amount of experience. Mr. Treat was immediately in charge of that work. He was the contractor under the company.

Mr. DOOLITTLE. Do not you know that the labor employed there was satisfactory?

Colonel LUDLOW. I have understood so.

Mr. DOOLITTLE. And, owing to the fact that silver was made use of for the payment of the wages of those men, that the labor was much cheaper, according to the accomplishment, than in the United States on a gold basis?

Colonel LUDLOW. Oh, yes; the labor is cheaper and proportionately less effective, too.

Mr. DOOLITTLE. I say in accordance with the accomplishment of the laborer it was much cheaper than the laborer on such work in the United States.

Colonel LUDLOW. It depends upon what you mean by that. Colonel Rives and Mr. Keith would tell you it is not cheaper, and that while they got less they did so much less that the work costs twice as much.

Mr. DOOLITTLE. Do you mean to say the same amount of work done there would cost twice as much in gold as in the United States?

Colonel LUDLOW. As the same amount of work done in the United States.

Mr. DOOLITTLE. Would cost twice as much in gold?

Colonel LUDLOW. That is our understanding of the distinct declaration of those gentlemen.

Mr. DOOLITTLE. It would cost twice as much in gold?

Colonel LUDLOW. In gold, standard value.

Mr. SHERMAN. In other words, the work is worth one-fourth of what it is here?

Colonel LUDLOW. Practically, if you choose. If they are only paid half the wages, the work done there would be practically one-fourth, if you choose, by their general estimate of it. We had nothing to steer by ourselves except a number of opinions and statements, and according to the statements of those gentlemen if you want to estimate the cost of a piece of work in Nicaragua you estimate the cost of it in the United States and multiply that cost by two and you will get down to what it would cost in Nicaragua.

Mr. PATTERSON. You mean by this the amount of labor which would cost $100 in gold in the United States—I mean the number of days of work—could be purchased in South America for $100 in silver, but the result of that day's work would only be half?

Colonel LUDLOW. One-fourth, practically. There is another divisor there. A given amount of work in Nicaragua would cost twice what it would cost in the United States, and you can figure it any way you like.

Mr. PATTERSON. That is the result?

Colonel LUDLOW. That is the outcome.

Mr. PATTERSON. Suppose there is a job of work that will cost $10,000 in gold in this country. You can employ men in Central America to work on that job, paying them the same per diem in silver that is paid in the United States in gold, but still at the same time when the work was completed it would cost $20,000?

Colonel LUDLOW. Twice as much as in the United States. I think there is no doubt about that.

Mr. NOBLE. And that opens up the question of what the wages would probably be in case there was a large demand for labor.

Colonel LUDLOW. That is true. That estimate includes everything. It includes disease and sickness, and extra employment, if you please, of skilled labor as well, and in many cases duplicate skilled labor you have to have, because you can not get another fellow if this man gets sick. It includes all these contingencies, and inasmuch as it was impossible to go into all details, we accepted as a general guide of our judgment, with modifications for particular localities, that the cost of the work in Nicaragua would be substantially twice what it would be in the United States for a given piece of work. That is as definite and as clear as I can make it.

Mr. PATTERSON. In other words, if it costs so much to construct such a work in the United States, say $75,000,000, in South America it would cost $150,000,000 of the same kind of money, practically?

Colonel LUDLOW. That is precisely what I mean to say.

Mr. DOOLITTLE. Does that apply to anything but labor?

Colonel LUDLOW. That applies to the whole thing.

Mr. DOOLITTLE. Do you think that applies to machinery?

Colonel LUDLOW. Everything in which the element of cost enters.

Mr. DOOLITTLE. That is, a dredge down there would cost twice as much as in the United States, and powder would cost twice as much, and cement would cost twice as much——

Colonel LUDLOW. No; not at all.

Mr. DOOLITTLE. That is what you said.

Mr. PATTERSON. You do not mean that the items would cost twice as much, but the whole cost would be twice as much?

Colonel LUDLOW. That is it exactly. You undertook to apply that general statement to each independent item, and it does not; but you talk about dredging. Suppose you made a contract with Mr. Bates to go to Nicaragua and dredge a million yards or ten million yards. He would give you a certain price for it. Would not that price include getting the dredge there?

Mr. DOOLITTLE. Naturally.

Colonel LUDLOW. Naturally; and that is one element of cost.

Mr. DOOLITTLE. How much would that be?

Colonel LUDLOW. It would include possibly, if the work was sufficiently large, sinking his dredge in the work; he would charge the whole cost of his dredge.

Mr. DOOLITTLE. Would not that same rule apply to any work in the United States?

Colonel LUDLOW. Oh, surely; but look at the distance you have got to go.

Mr. DOOLITTLE. You are speaking now on the subject of dredging. What do you suppose will be the cost to take one of the dredges built as these dredges are, perfectly seaworthy, from San Francisco to Brito?

Colonel LUDLOW. What would be its use at Brito?

Mr. DOOLITTLE. Or, say, from New Orleans to Greytown?

Colonel LUDLOW. What would you do with it if you had it there?

Mr. DOOLITTLE. Make use of it in the construction of the canal?

Colonel LUDLOW. How could you use it on the canal? There is no entrance; you can not get in there; there are no harbors there. You can not do anything with a dredge taken down in that way.

Mr. DOOLITTLE. Then you state to the committee that a canal that would cost $100,000,000 in the United States of the same character as the Nicaragua Canal in that country would cost $200,000,000?

Colonel LUDLOW. That is exactly what we mean, and that is precisely what we understand to be the case. Now, since I have referred here to gentlemen who have had experience in these things, we find that opinion further confirmed by the estimate of Colonel Childs, who was a very competent engineer, and he made a very careful survey of the canal across the Isthmus and reported in 1852. He gives in parallel columns the price of the construction of that canal according to the New York prices, and then makes an estimate according to Nicaragua prices derived from the use of his best judgment in using the local labor and taking into account all local conditions. Now, it is rather remarkable that Colonel Childs's Nicaragua figures are almost exactly double the New York figures.

Mr. PATTERSON. Just one question. Now, you spoke of conferring with Mr. Rives and other gentlemen, Mr. Rives having had long experience on the route of the Panama. Now, my understanding is——

Colonel LUDLOW. And in the United States also, if you please, prior to going down there.

Mr. PATTERSON (continuing). My understanding is that at Nicaragua the conditions prevailing there are much more adverse to life, and that natural causes augmenting, the cost of that work there might be much greater than at Nicaragua. My information is, after you get out of the alluvial land there, all along that river and this lake, that the climate is comparatively healthful compared with the route at Panama, and I want to know now if you think there ought not to be a discount in your estimate growing out of the difference in the conditions at those two *points?*

Colonel LUDLOW. I apprehend, sir, that if the discount were to be made, it would have to be the other way. I should be afraid to make the discount in favor of the Nicaragua route.

Mr. PATTERSON. Why?

Colonel LUDLOW. Well, for one reason, the rainfall at Panama is only about one-half that at Nicaragua. That in a construction question is a very important one. We have records from Colonel Rives of the Panama rainfall, and we have a partial record of the Nicaragua rainfall, and a comparison of the two shows the rainfall on the whole is about one-half on the Panama line what it is on the Nicaragua line. That, of course, would be a distinct advantage in favor of the Panama, both having, however, an excess of water in either case. The Panama route has another very marked advantage, if you choose—I am not advocating the Panama route, but I am stating in answer to your question what I believe to be the facts—it has an immense advantage in that at both ends are absolutely safe and capable harbors. They are in constant and daily use, and have been for years, by steamers of all dimensions, practically.

There is a harbor at Colon—and an excellent one—and there is a harbor at Panama—and an excellent one—perfectly sheltered and safe. Furthermore, the distance across the Isthmus of Panama is only 47 miles, while the distance across the Isthmus of Nicaragua is 170. Furthermore, the Panama Railroad has for forty years been in existence at Panama, and immediately adjoins the line of the canal the whole distance, with all facilities for landing, distributing, and transporting material, men, and everything else. In certain respects the physical conditions at Panama are very favorable as compared with those existing over the other route. Now, then, on the other hand, if you choose, I will lean——

Mr. DOOLITTLE. Give us the other side of the picture.

Colonel LUDLOW. I will lean a little that way. On the other hand, the sanitary history of the Panama enterprise is very dreadful. The mortality down there, both in the construction of the railroad and the construction of the canal as far as it has gone, and it is apparently about half built, was very great indeed, very great; the mortality was tremendous.

Mr. DOOLITTLE. Do you remember what percentage it was during any given time?

Colonel LUDLOW. No, it is not easily ascertained. The hospital records show the mortality. Of course, it is not likely we would really get the whole of it, because people do not like to publish those particulars.

Mr. PATTERSON. Have you any reason to believe there would be less mortality at Nicaragua?

Colonel LUDLOW. I think we have reason to believe it would be less. All the same, you go down to the Costa Rica Railroad, which leaves the coast and presently climbs the mountains and gets into almost the most magnificent country you ever saw. Mr. Keith told us when he came to build the railroad he had, of course, to import the labor. You can not get those natives down there to do work of that kind. They are not fit for it, or qualified to do it, and they do not want to do it. He tried to get the Jamaica negro, but the Panama Canal was drawing largely on the Jamaica resources, and he could not get what he wanted. He imported negroes from the United States, and he imported Chinamen, and imported Italians. The United States negroes were of very little good down there. They were discontented and unhappy, and died off

like sheep. The Chinese rotted. Out of the large number—several hundred—of the Italians whom he imported, very few of them ever got away. They are there now. The Jamaica negro is the fellow who seems to stand that sort of thing better than anybody else, and they did better with him, and after awhile they were able to get enough of that labor to go on and complete their work, but all the while the mortality was great, and according to these men it was extremely formidable.

Now, at Nicaragua they have had some experience, but very little practical experience, of this kind. The difficulty seems to come about from these terrible epidemics of pernicious fever and all kinds of fevers. It is as soon as you begin to break the ground, and particularly when you begin to drink the water in the vicinity of the broken ground; it seems as though the soil undisturbed was all right. We went through that country without having an attack of fever or anything else. The health statistics of Nicaragua are very satisfactory, at Greytown particularly. They have fevers there, but they have fevers everywhere in low lying countries, and we found no more indications of mortality in Nicaragua, Greytown or elsewhere, than in numerous places on the Gulf coast or on our South Atlantic and other coasts where the districts are supposed to be malarious.

Mr. PATTERSON. There was a considerable section of the railway constructed out from Greytown?

Colonel LUDLOW. Yes, sir; 11¼ miles of it.

Mr. PATTERSON. And there seems to have been a very considerable force employed at that time?

Colonel LUDLOW. There was quite a force.

Mr. PATTERSON. Did you make inquiries to ascertain the mortality in regard to that?

Colonel LUDLOW. It has been stated in the company's papers, and we have dealt with that. They gave us hospital records for that work and they were very satisfactory, but we could not disregard the fact and fail to take into account the conditions of the labor. These men were not excavating clay. They were not digging through clay. They were described in the canal company's reports as building a railroad through the swamp knee deep or up to their necks in the water. Now that is another important thing. The American negro can work in a rice field without getting any serious effect out of it, where it would kill a white man.

Mr. DOOLITTLE. Is not that about as unhealthy as it would be——

Colonel LUDLOW. Apparently the unhealthy thing is disturbing the ground. When you begin to break the clay and drink the water, that is the time of trouble, and it will not be safe to assume that there would not be a very considerable mortality in connection with any of that work in that portion of country. You have to make hospital districts, to make all hospital arrangements with great care, and you have to have your hospital regulations rigidly enforced, and you must not allow men to drink rum in that country, and you must have a dry place for them to sleep. Those who were employed in building this railroad at Greytown were brought back at night to Greytown to sleep.

Mr. DOOLITTLE. Do they have yellow fever at Nicaragua along the line of this canal?

Colonel LUDLOW. They have some yellow fever in Nicaragua, but it is not important or a difficult matter. They have another class of fever which the people call "pernicious fever."

Mr. DOOLITTLE. Is the yellow fever ever prevalent there? Are not those cases brought in, and is it not frequently the case they are brought from Panama for restoration to health?

Colonel LUDLOW. I think if you will do the board the honor to examine its report, you will find we have stated that very fact in our report.

Mr. DOOLITTLE. That is done. Then there is no prevailing type of fever aside from this malarial fever of which you spoke?

Colonel LUDLOW. They have malarial fever and the pernicious fever of which I spoke. The doctors dislike to refer to it as yellow fever, but it kills a man in a day or two. I believe the distinction between yellow fever and pernicious fever is that one is contagious and the other not, or something of that kind.

Mr. DOOLITTLE. But Nicaragua is healthy compared with Panama?

Colonel LUDLOW. On the whole, I think the conditions are better, and I doubt if the Panama enterprise ever had proper hospital care, etc. I think the mortality at Panama and Costa Rica could be very much diminished at Nicaragua, and the board has taken that view of it, and we are very glad to do it.

Mr. DOOLITTLE. Now, I have noted an item of four millions for management and engineering to which 20 per cent is added, making $4,800,000. Please segregate the items and describe in detail the organization which would cost this sum in gold coin—that is, the $4,800,000?

Colonel LUDLOW. On what page is that? Do you refer to our report?

Mr. DOOLITTLE. Yes, sir.

Colonel LUDLOW. I will examine it. For management and engineering we made a round sum for that which represents a certain percentage of the total estimated cost of the work. That is all that it represents.

Mr. DOOLITTLE. Now I ask this: Twenty per cent is added, making $4,800,000; are you able to segregate the items and describe in detail the organization of the management which would cost this sum in gold coin?

Colonel LUDLOW. We do not make the figures in that way. We put that figure as a percentage on the total cost of the work.

Mr. DOOLITTLE. For management?

Colonel LUDLOW. For management and engineering. It is the usual practice in estimates of this kind.

Mr. DOOLITTLE. How much of that would be engineering and how much would be for management?

Colonel LUDLOW. They all run in together.

Mr. DOOLITTLE. They must have been segregated at some time during their consideration?

Colonel LUDLOW. They were not.

Mr. DOOLITTLE. Should not that have been done?

Colonel LUDLOW. I do not know it should have been done.

Mr. DOOLITTLE (continuing). By apparently competent engineers, such as constituted your board?

Colonel LUDLOW. Understand, our time was somewhat limited.

Mr. DOOLITTLE. I understand.

Colonel LUDLOW. We could not examine every point.

Mr. DOOLITTLE. But here is a very large amount of money, $4,800,000, and it seems to me ——

Colonel LUDLOW. It is not $4,800,000; it is $4,000,000.

Mr. DOOLITTLE. But if you add the 20 per cent it makes $4,800,000?

Colonel LUDLOW. Oh, of the whole thing, yes.

Mr. DOOLITTLE. I should like to know very much how that amounts to that great sum?

Colonel LUDLOW. It represents a certain per cent of the total cost of

the work, which, in an enterprise of this kind, is usually charged in that way.

Mr. DOOLITTLE. You say "usually?"

Colonel LUDLOW. Yes, usually.

Mr. DOOLITTLE. In what cases is it charged in that way?

Colonel LUDLOW. In almost all cases of that sort. I am going to quote an illustration of that from a report which the company had from the Bogart board. Do you remember that?

Mr. DOOLITTLE. Very well.

Colonel LUDLOW. It was a board of consulting engineers, which board met in New York to consult the data and make a report, and it reported on the estimates of the company with the company's data and figures. Now, if you will examine that, you will find that the Bogart board added a sum to the company's estimate at that time of not less than $6,250,000, covering engineering, management, labor agencies, shops, police, sanitary service, and incidentals.

Mr. DOOLITTLE. Now, I suppose that was composed of elements?

Colonel LUDLOW. Here they are; they lump them together under that sum of $6,250,000. This is the company's own board, you understand.

Mr. SHERMAN. That gives certain elements, and you do not give any elements.

Colonel LUDLOW. I beg pardon; we give practically the same heading. We call ours "management and engineering." We might have called it "administration and engineering."

Mr. DOOLITTLE. And your estimate here is $4,800,000?

Colonel LUDLOW. While the Bogart board put it at $6,250,000, with 20 per cent added for contingencies, making $7,500,000.

Mr. SHERMAN. But they specify more headings than you do?

Mr. DOOLITTLE. It would be supposed that these elements were considered by these people. I would like to know in regard to it very much, and I think the committee would like to know.

Colonel LUDLOW. We specify even more fully than that, because the hospital service is a separate charge, and even after you have added the management and engineering items of $4,000,000 and the hospital service of $1,000,000, we are still a million and a quarter short of the Bogart board's estimate for similar services. I do not think we were unduly extravagant in that respect.

Mr. DOOLITTLE. In what intelligible way do you add the 20 per cent for contingencies; on account of what?

Colonel LUDLOW. Unforeseen and unspecified amounts which you can not anticipate, and you do not know how to consider.

Mr. DOOLITTLE. In management and engineering?

Colonel LUDLOW (continuing). But which you know are inevitable, which are always inevitable, and which experience has demonstrated are inevitable, and the contingencies of a work of this kind is always an extremely formidable item.

Mr. DOOLITTLE. And you are unable to state to the committee what the elements are that make up that amount of $4,800,000?

Colonel LUDLOW. Why, they are all the elements which in the conduct of a work of this kind would come under the head of management and engineering.

Mr. DOOLITTLE. I mean the relative prices of each particular——

Colonel LUDLOW. What is management and what is administration?

Mr. DOOLITTLE. How much will that cost?

Colonel LUDLOW. There are headquarters, offices, salaries to be paid, engineers, which constitute the company's service, have to be paid—that *is all staff, that is all* management, all engineering.

Mr. DOOLITTLE. How many of them in a work of this kind would you say would be under this estimate, to make up this estimate. That is what I am trying to ascertain.

Colonel LUDLOW. Really, you can not expect that. I am no intellectual giant. I only know what I know, and I am willing——

Mr. DOOLITTLE. You are an intelligent, practical engineer?

Colonel LUDLOW. I profess to be, quite.

Mr. DOOLITTLE. When a large sum of this kind is made up and submitted, we would like to know in regard to it.

Colonel LUDLOW. There is a much larger sum of the company's just below.

Mr. DOOLITTLE. But it seems to me we ought to know about that when we are considering the cost of this work, and I would like to know whether or not, in your judgment, after going over these elements, these might not be cut down. That is what I am desirous of doing. I want to get at the kernel of it.

Colonel LUDLOW. It is a comparatively small percentage on the total estimate of the cost of the construction of a work of this kind.

Mr. DOOLITTLE. What is the percentage including the 20 per cent?

Colonel LUDLOW. It is about 3 per cent.

Mr. DOOLITTLE. That is including the 20 per cent you have added?

Colonel LUDLOW. Yes, sir; it is a bagatelle.

Mr. DOOLITTLE. Twenty per cent is one-fifth of the whole amount, and would not seem to be an insignificant amount at all in proportion?

Colonel LUDLOW. But the $800,000 is an insignificant amount in comparison with the items we are figuring, and do you suppose it is possible for anybody to make a close estimate of this project from the information we have had?

Mr. DOOLITTLE. I suppose you would be able to arrive at some conclusion in order to arrive at the elements which make up the sum of nearly $5,000,000 to tell this committee what they are for?

Colonel LUDLOW. If you make that request we will go to work and get it up, but I do not know what use it will be after you get it.

Mr. DOOLITTLE. It would enable the committee to judge intelligently in regard to that estimate.

Colonel LUDLOW. Would it?

Mr. DOOLITTLE. Yes, sir.

Colonel LUDLOW. This is all there is about it. This estimate of 3 per cent for management, superintendence, etc., is about the usual allowance made on work of this kind, and why should we not have accepted that without undertaking to build up our details which are impossible to formulate, if you choose, I do not know. Suppose you want to do this work. How do you go to work to do it? First you formulate your project, so as to understand what you have to do and know how you are going to do it. Then you block that off into sections of a certain kind; they are bid for by contractors independent of the other sections, or conjointly with them if you choose. Now all that kind of preliminary organization with a view of getting to work must of necessity follow the final preparation of your project and full ascertainment of the price. We are not prepared to put this work under contract until we make specifications for it——

Mr. PATTERSON. Let me see if I understand you. The labor contingencies, shops, police, sanitary services, incidentals, etc., would come under the general terms of administration?

Colonel LUDLOW. "Management and engineering," we call it.

Mr. PATTERSON. Or administration?

Colonel LUDLOW. If you choose.

Mr. PATTERSON. Now, the experience of engineers is that about 3 per cent of the total cost is taken up with those expenses coming under that head?

Colonel LUDLOW. Yes.

Mr. PATTERSON. But it would be very difficult in the outset to calculate and say how much of that would be paid for labor agencies, how much for shops, police, sanitary service, and incidentals; but engineers, in making an estimate, generally estimate that the cost of this engineering and management, or administration, will be about 3 per cent of the total cost of the work?

Colonel LUDLOW. You have got it exactly; I could not have expressed it better.

Mr. DOOLITTLE. That is true, is it not, where work is taken at the beginning of all great work of this character without surveys?

Colonel LUDLOW. Yes. Well, there is a good deal of surveying work that has been done there; but it is a question of engineering, if you please. Your project is supposed to have been completed. You have made your preliminary surveys; you have made your final investigation and final project and prepared your specifications, and you want to put your work under contract. We would suppose that this is where you begin. We begin, say, with the completed project and specifications for the work and preparations, issue advertisements, and invite these gentlemen to come in and bid on them. We have reached no such point yet.

Mr. DOOLITTLE. Is it usual to charge up 3 per cent against the work on account of management and engineering——

Colonel LUDLOW. And administration and outside expenses, labor agencies, and so on.

Mr. DOOLITTLE. Do you say it is usual then?

Colonel LUDLOW. Yes; that is what it is for.

Mr. DOOLITTLE. I understood you to say a moment ago the 3 per cent was charged when the work was first undertaken?

Colonel LUDLOW. I did not mean in order to make preliminary surveys.

Mr. DOOLITTLE. In what great work of this kind have you ever known that to be done?

Colonel LUDLOW. What?

Mr. DOOLITTLE. To charge 3 per cent for management and engineering after the preliminary engineering had been done?

Colonel LUDLOW. There are the estimates made on this work by the Bogart board at New York.

Mr. DOOLITTLE. Did not that contemplate the entire work of the canal?

Colonel LUDLOW. Not in the least.

Mr. DOOLITTLE. Preliminary surveys and everything else?

Colonel LUDLOW. Not in the least. Their report is in 1889.

Mr. DOOLITTLE. Now, you have an item of $1,000,000 for hospital service, to which is added 20 per cent, making $1,200,000?

Colonel LUDLOW. Yes.

Mr. DOOLITTLE. Why did you not consider the modern contract and railroad practice in this country by which $200,000 spent on buildings and apparatus would amply suffice, and that a deduction from the pay roll of $1 per month per man would liberally support them without further cost? Why is there not here a saving on engineer management and hospital accounts?

Colonel LUDLOW. What is all this about railway practice?

Mr. DOOLITTLE. Do not you understand it is the practice of railway construction here to retain $1 per month from the wages of every man employed, or a proportion of that per week for hospital dues, and in that way the hospital service is kept up? Do you know that is true?

Colonel LUDLOW. I think very likely it is true.

Mr. DOOLITTLE. Could not that be done with advantage in this work?

Colonel LUDLOW. With the Jamaica negro?

Mr. DOOLITTLE. With the Jamaica negro or any other laboring man.

Colonel LUDLOW. I think if you hire him for so much per week, or so much per day, or so much per month, he would rather receive that sum, and furthermore the company ought to do that itself for two or three reasons. You have half a dozen contracts on that job——

Mr. DOOLITTLE. And you have half a dozen systems of hospital service?

Colonel LUDLOW. You would come pretty near it.

Mr. DOOLITTLE. Why could not those be paid as other laborers employed on great works pay for them?

Colonel LUDLOW. Do you suppose whether you pay that money to the laborer and take it back again or whether you pay him the difference and keep it, or do not pay him at all, it is going to pay for the cost of these hospitals?

Mr. DOOLITTLE. Why could not it be done there just as it is done in other instances, and which is a universal practice?

Colonel LUDLOW. In which an additional allowance is made and then it is taken back again?

Mr. DOOLITTLE. It is not taken back; it is simply retained.

Colonel LUDLOW. For hospital service?

Mr. DOOLITTLE. Most surely.

Colonel LUDLOW. There is no contingency service down there. You have to build your hospitals.

Mr. DOOLITTLE. Certainly you build the hospitals, and then you retain a portion of the wages, as is done in this country on all these great works, a percentage for hospital service. Do you know of any good reason why this system could not be adopted and made use of in the construction of the Nicaragua Canal?

Colonel LUDLOW. Yes; you would save nothing by that arrangement at all.

Mr. DOOLITTLE. Can you explain to the committee why something is not saved when this dollar a month is taken out of the wages, or that proportion weekly is taken out of the wages, of every man employed on the work; is not that a saving to the company and a reasonable condition?

Colonel LUDLOW. It is very much as if you undertook to make a contract with the contractor by which he agrees to make a certain amount of excavations, furnishing his own railroad——

Mr. DOOLITTLE. Do you not know that system is universally made use of in this country?

Colonel LUDLOW. I do not know that it has anything to do with things down there. The conditions are not comparable in a civilized country like this where a railroad employee if he is hurt can be sent to a hospital at the end of the line, or at some portion of the line, and the expense is paid by the company, which reimburses itself by collecting out of the wages; it is a totally different thing in an uncivilized country down there where you have to create everything.

Mr. DOOLITTLE. The men are paid as in other countries at stated times?

Mr. PATTERSON. Would not an arrangement of that kind referred to by my friend, Mr. Doolittle, necessarily result in paying the laborer a dollar a month more?

Colonel LUDLOW. In order to get it back again; that is exactly the point I make.

Mr. DOOLITTLE. Why do you say that? Why would not the laborer down there submit to that custom which operates to protect them as anybody else?

Colonel LUDLOW. Is it the intelligent and civilized American laborer you are talking about?

Mr. DOOLITTLE. Is the intelligent and civilized American laborer employed in the United States on that kind of work?

Colonel LUDLOW. It comes pretty near it.

Mr. DOOLITTLE. I do not think it is.

Colonel LUDLOW. You are not going to do it down there.

Mr. DOOLITTLE. Do you not know that gangs of Italians employed in this country are employed under conditions of that kind on those great works?

Colonel LUDLOW. I think it is very likely, because there are hospitals around; there are none down there.

The CHAIRMAN. May I sumbit that this colloquy is scarcely pertinent, and it is immaterial to the purposes of this investigation?

Mr. DOOLITTLE. Here is an item of a million dollars?

Colonel LUDLOW. There is a great deal more than that in this item.

The CHAIRMAN. I think it is not material.

Colonel LUDLOW. I will say this in a general way that our estimate of a million dollars was made up on the assumption that we might have to provide somewhere between four or five hospitals, and that a sufficient sum should be allowed for construction and equipment of these hospitals for a number of men amounting to perhaps 10,000, 15,000, or 20,000 without much facilities for transportation to and fro and that sort of thing; and without mixing up the work of one contract with the work of another, we thought it would be better to take the eastern, separate the different sections, it being a long distance over to the western division, and thought perhaps there would be four or five hospitals, one at each of the two harbors, one possibly on the left of the lake, or on the east side at the exit of the San Juan River, and possibly another in the San Francisco basin or on the east divide. In a general way we considered that would be what it would be necessary to do.

Mr. DOOLITTLE. Now, for management and engineering and this hospital service the estimate amounts to $6,000,000 in round numbers. Need they cost that under usual prevailing methods of management?

Colonel LUDLOW. It is the usual percentage, that is the reason.

Mr. DOOLITTLE. You think they need cost that under prevailing methods?

Colonel LUDLOW. Yes, sir; you are going into a strange country. You have to run your administration here and there too.

Mr. DOOLITTLE. Now, I wish you to state to the committee the elements of expense in the dredging?

Colonel LUDLOW. Dredging where?

Mr. DOOLITTLE. In Nicaragua—in dredging the canal, lake, river, etc.?

Colonel LUDLOW. The elements of expense are the preparation of the plant and its delivery at the site where it is to be used; the taking down and transportation from the United States or elsewhere of all the skilled

and unskilled labor you want, and establishing down there machine shops, forges, repair shops, and maintaining your plant while you have got it—the country has none; the delivery of all your supplies while the work is in progress—your food supplies, your clothing supplies, your supplies of coal, in particular—all have to be delivered on the site of the work. In other words, the plant, all materials, all service have got to be taken, if you please, away from here and delivered there, and thereafter maintained. Furthermore, inasmuch as there is no reserve in that country of skilled or other labor that you can use, you have got to provide what in this country would be a very large excess of that labor, or otherwise you will be paralyzed. If one engineer in Chicago can run the dredging, it will take two down there, because you can not telephone up to Chicago and have another one sent down if this man is suddenly stricken with illness; so you have got to have something over. Those are the items which enter into the cost. We have said nothing about the nature of the work, which, of course, is very important——

Mr. DOOLITTLE. In taking up the subject of dredging——

Colonel LUDLOW (continuing). I was going to state one more element of cost; and that is, taking the plant so great a distance from home and using it for years practically means to charge the whole value of the plant into the cost of the work.

Mr. DOOLITTLE. Now, in considering the subject of dredging, your board took up the different elements, I suppose, of the harbor at Brito and perhaps at Greytown?

Colonel LUDLOW. Yes.

Mr. DOOLITTLE. And the lake and the river?

Colonel LUDLOW. Yes.

Mr. DOOLITTLE. And along those places where the embankment was—wherever dredging was required, if it was required?

Colonel LUDLOW. There is no other dredging in there. That would be done in the dry.

Mr. DOOLITTLE. Are you able at this time to segregate those items for Greytown, Brito, and toward the first lock, the river, and the lake, and give us your estimate upon those different items?

Colonel LUDLOW. Yes; we tried to get some information of this kind as exhibits—not a finality, if you please, but as a basis for our judgment in making unit prices for this work in the different portions of the project. That we did, and I will, if you please, simply read the statements I have here dictated from data which we regarded as regulating, controlling, and guiding our judgment in the formation of the unit prices there.

Mr. DOOLITTLE. Where do you mention—at what portion of the dredging?

Colonel LUDLOW. I think, as a matter of fact, we commenced—I think locally—we commenced at Brito or Greytown.

Mr. DOOLITTLE. Will you just take up each item by itself?

Colonel LUDLOW. First there are general considerations which apply to the whole work.

Mr. DOOLITTLE. Is not that a portion of the report [referring to paper in Colonel Ludlow's hand]?

Colonel LUDLOW. This? Oh, no; we spent all day yesterday going over this together. I do not know what the District laws are in regard to working on Sunday, but——

Mr. DOOLITTLE. Can you state at the outset what the dredging will cost at Greytown?

Colonel LUDLOW. We can tell you about what we calculate it will

cost. It is about 40 cents per cubic yard at the entrance, 20 cents inside, making an average price of 25 cents per cubic yard.

Mr. DOOLITTLE. At Brito, what was your price for dredging?

Colonel LUDLOW. This dredging, 25 cents—the same thing.

Mr. DOOLITTLE. And in the lake?

Colonel LUDLOW. It is 20, if I remember, and the river is 30 cents per cubic yard.

Mr. DOOLITTLE. Now, from Greytown Harbor up to Lock No. 1?

Colonel LUDLOW. We threw that, too, into the 25-cent price, if I remember.

Mr. DOOLITTLE. When you figure it 25 cents per cubic yard for dredging Greytown Harbor, what profit did you include?

Colonel LUDLOW. About 20 per cent to the contractor.

Mr. DOOLITTLE. Not to exceed that?

Colonel LUDLOW. No; I think not. We estimated that is what he would demand or expect.

Mr. DOOLITTLE. Did you calculate any margin for a contractor or construction company——

Colonel LUDLOW. I did not get that.

Mr. DOOLITTLE. Did you calculate any margin for a contractor or construction company?

Colonel LUDLOW. I have answered that; that we allowed a margin of 20 per cent as contractor's profit, as an engineer would call it. I do not know who would get it, a contractor or his associated interests, whatever they were.

Mr. DOOLITTLE. Now, you said at Greytown you estimated the dredging at 25 cents. Are you aware of what it is costing the Government a day per cubic yard to do similar work at the Galveston jetties with a modern plant?

Colonel LUDLOW. No; I have not those figures of Galveston in my mind.

Mr. STEWART. Has your experience abroad since you helped to prepare this report and your examination of foreign work affected your judgment as to the figures in this matter at all?

Colonel LUDLOW. It has somewhat.

Mr. STEWART. Do your colleagues agree with you?

Colonel LUDLOW. That is my own judgment, and I have not had an opportunity to confer with them. It has not modified my judgment in the direction of diminishing our prices; it is the other way.

Mr. DOOLITTLE. How would this dredging work differ so far as the removal of the material is concerned from that at Galveston?

Colonel LUDLOW. I am really not familiar with the particulars at Galveston.

Mr. DOOLITTLE. But I am speaking of the material now.

Colonel LUDLOW. No; it is all sand at Galveston, I judge, and the harbor at Brito and Greytown is pretty much sand and mud and is easily handled—not bad material to handle. I think at Galveston it is sand, if I remember the circumstances, but I do not remember the contract specifications.

Mr. DOOLITTLE. Now then, if it does not cost the Government more than 8 cents per cubic yard at Galveston, why should the charge of 25 cents be made per cubic yard at Nicaragua?

Colonel LUDLOW. Well, the contractor will charge more to go to Nicaragua, will he not?

Mr. DOOLITTLE. Well, I am asking you why it should cost 25 cents at Nicaragua and only 7 or 8 cents at Galveston.

Colonel LUDLOW. Suppose we clear the subject up——

Mr. DOOLITTLE. I would like to have that done.

Colonel LUDLOW. By reading these notes we have here. The general considerations, you understand, cover all this, and then the particular considerations affect particular portions of the work——

Mr. DOOLITTLE. But if it only costs 7 cents at Galveston, would you as an engineer say it would actually, under careful management, with modern methods, cost 25 cents at Nicaragua?

Colonel LUDLOW. We think so, or we would not have estimated it at that.

Mr. DOOLITTLE. Did you know at the time it was only costing 7 cents in the United States?

Colonel LUDLOW. It was costing about 7 cents at Mobile, an illustration which we embody in our report. We found the physical conditions of the work at Mobile Bay are quite similar and the nearest we can find in the United States to the work at Nicaragua, and if you choose to read the report you will find we refer to it. I do not know what the Galveston conditions are. I do not know what the price is at Mobile, except it is about 7 cents. I mean, I do not know the particulars which enter into that price there.

Mr. DOOLITTLE. The double of those figures would be 14 cents, while in Nicaragua, in your estimate, you run it up to 25 cents.

Colonel LUDLOW. Yes; we do.

Mr. DOOLITTLE. I wish you would state to the committee what elements there are that would increase the amount over the amount paid in the United States for the same sort of work of from 7 cents to 25 cents.

Colonel LUDLOW. All right. In a general way I have answered that question, part of it, a very important part of it. A much greater cost of work down there in every respect——

Mr. DOOLITTLE. Doubling would not make it.

Colonel LUDLOW. You can double it right off if you choose, because we regard that in a general way as a fair comparison between Nicaragua work and United States work. Then there is the sinking of the plant in the job, which might have something to do with it.

Mr. DOOLITTLE. The same thing would be done at Galveston—the plant would be sunk in the job?

Colonel LUDLOW. No.

Mr. DOOLITTLE. With the great work there. Has there not been many a plant sunk in the job and charged up to it?

Colonel LUDLOW. There might if——.

Mr. DOOLITTLE. If the machinery is worn out entirely?

Colonel LUDLOW. There might be.

Mr. STEWART. If a responsible contractor in this country should undertake to carry through this project at a given price, would that alter your judgment as to the feasibility of carrying through that at a certain price? I am referring to a man who understands the building of canals, etc.

Colonel LUDLOW. I suppose if he understood the local conditions and had made a full investigation and had undertaken to do the work, with a full knowledge of the nature of the enterprise, it would be a valuable guide, and it was that kind of information we were in search of last summer.

Mr. STEWART. Does not Mr. Treat understand those conditions?

Colonel LUDLOW. He is a very able and intelligent contractor, but he is not a safe person to call on in this respect.

Mr. PATTERSON. Why?

Colonel LUDLOW. For the reason that his proposition does not embrace this work.

Mr. DOOLITTLE. Suppose it actually does embrace this work?

Colonel LUDLOW. Then it would be an important consideration.

Mr. STEWART. I understand he does embrace the whole project. Is that so, Mr. Miller?

Colonel LUDLOW. He had not when we talked with him last summer. Mr. Treat was good enough to come and see us. He was a very important person with whom we wanted to confer, and he was good enough to come to the office and confer with us and to furnish us with a copy of the proposition he made to the canal company. It was after we were back in New York, in August or September of last summer, and at that time his proposition related exclusively to the western division, and he stated he refused to have anything to do with the eastern division.

Mr. STEWART. Just read his letter, if you please?

Colonel LUDLOW. I have no hesitation in reading this letter. I read it under the reservation that he may have made another proposition of which we have no knowledge. This letter is dated July 2, 1895. If there is a subsequent proposition, of course this is modified, and I do not know anything about that and have not heard of it. This letter is addressed to John R. Bartlett——

Mr. CORLISS. Is there any necessity of occupying time in reading that letter?

Mr. PATTERSON. I prefer to have it read.

Colonel LUDLOW. It ought more properly to have been called for from the recipients of the letter and not from our side. However, we feel entirely authorized by Mr. Treat to use this letter. He talked to us freely on the subject, and we had a most interesting talk with him, and he had no hesitation in leaving with me a copy of this letter, and said he had no hesitation in our having it. It was a very important contribution to the information on the subject.

Mr. STEWART. That can not be a copy of the letter addressed to Mr. Warner Miller?

Colonel LUDLOW. I do not know anything about a letter addressed to Mr. Warner Miller. This is addressed to the president of the canal company and was handed in by Mr. Treat himself to us.

Mr. DOOLITTLE. I do not know that it is any value one way or another.

Mr. PATTERSON. Let us have the letter, please; I prefer to have the letter read.

Copy.

HOULTON, ME., *July 2, 1895.*

DEAR SIR: Referring to our interview of the 17th of June, and in response to your invitation, I herewith below submit to you the following bid:

I propose to build for your company the western division of the Nicaragua Canal, from Lake Nicaragua to the Pacific Ocean, including any work east of the shore of the lake and except the dredging, on the following terms and conditions:

I will in general accept the prices for units of measurement as given in the estimates of A. G. Menocal, esq., chief engineer, under date of January 31, 1889, and revised January 31, 1890, published on pages 144, 145, and 146 of Report No. 331, made to the Fifty-third United States Congress, at its second session, by Senator Morgan, of the Committee on Foreign Relations, subject, however, to the following conditions and amendments:

All necessary right of way to be furnished free to the constructor as required by him.

Sufficient land for a large camp, say 1 mile square, on the west shore of Lake Nicaragua, at the canal entrance, to be furnished free to the contractor during the continuance of work.

All rock, gravel, and sand necessary for construction purposes, and not obtainable from canal line excavation, to be furnished in place within reasonable distances.

There to be only two classifications in canal line excavation—namely, earth and rock.

The rock classification to include all that is not earth. In excavating for locks, earth and rock excavation under water shall be so classified and estimated, and a fair allowance made for cost of pumping, but not to exceed Mr. Menocal's estimate of $100,000.

All measurements of earth and rock and earth and rock under water to be made in excavation.

Not less than 2,000,000 cubic yards of material to be put into the dam at La Flor. This to be rock and earth in the proportions which may be directed by the engineer in charge, but all to be estimated and paid for at one and the same price.

Forty miles of standard gauge railway, with steel rails of at least 60 pounds per yard, to be paid for by the company, at $25,000 per mile.

All addition trackage and sidings to be furnished by the contractor at his expense.

All equipment for railway to be furnished by contractor.

The line and equipment to be maintained by contractor.

On completion of the work the 40 miles paid for by the company to belong to the company; the remainder of track and equipment to belong to the contractor. The contractor to have entire control and operation of road during continuance of contract.

The contractor to relieve the company of all responsibility and cost for medical attendance and hospital services.

The company to provide all necessary police, but the police to be under the orders of contractor, and payment to them to be made through the contractor.

Contractor to agree not to interfere with laborers of other contractors on the canal, but otherwise to be free to hire and import laborers, except as limited by canal concessions.

All payment to contractor to be estimated and made in gold, or its equivalent, except as otherwise provided below.

All materials of construction for the La Flor Dam, and for the locks and breakwater, and for that part of the railroad to be estimated and paid for by the company, to be paid for to the contractor by the company without reserve.

All proper freight bills on said materials to be estimated and paid to the contractor by the company without reserve.

The payment for such materials and freight bills for each month to be made in the next following estimate.

Proper invoices, showing the cost of such materials, shall be duly furnished by the contractor.

Payment by the company to the contractor to be made each month for the work done, and materials furnished, and freights paid during the preceding month.

Payment to the contractor to be made either at the contractor's office in Nicaragua, or at company's office in New York City, as he may elect; but he must give notice sometime during the month preceding the payment at which place he will receive the money.

The company to retain 10 per cent of estimates for work done in Nicaragua until the sums so retained amount to $1,000,000, which shall be included and paid upon the final completion of the work as a part of the final estimate.

The contract for dredging on the Pacific end of canal to be so arranged that there shall be no interference of work or forces of the contractor for dredging with the work or forces of the undersigned, and to that end the undersigned is to be called in conference before a contract for said dredging shall be made.

The contractor to locate railroad subject to approval of company engineers.

Contractor to provide all camp buildings, together with water supply and sanitary appliances for camp, at his own expense.

The company to see that all conditions of canal concessions are complied with by the Nicaraguan Government, so far as the contractor's interests may require.

If the contractor finds it necessary to remove the bar at the mouth of the Rio Grande River, in order to discharge from vessels supplies or materials before dredging is done by the company, then the company shall pay the contractor for the same at prices for dredging as given in Mr. Menocal's published estimate referred to above.

Prices to be changed from Mr. Menocal's estimates as follows: All grubbing and clearing to be $100 per acre, instead of $50 per acre. All earth and rock put into the La Flor Dam, 50 cents per cubic yard, instead of 20 cents per cubic yard. Earth excavation under water in locks, $2 per cubic yard. Rock excavation under water, $4 per cubic yard.

Lock gates and "guard gate" in divide cut, all machinery and buildings, crib piers, and swing bridges to be subject to arrangement between the company and the contractor as to plan and cost.

If agreement is not reached between them, then the contractor not to furnish them.

Outer limit of spoil banks not to be more than 500 feet from the edge of canal, but all spoil banks to be left in reasonably regular form, so as not to obstruct perfect freedom in the use of the canal, and so as not to endanger permanency of any part of the canal or structures pertaining thereto.

No greater proportion of cement to be required in concrete than that required in the locks of the Sault Ste. Marie Canal.

The contractor to take one-half his pay in first-mortgage bonds of the Maritime Canal Company of Nicaragua, at the lowest price at which they may be sold to bankers or others by the Northern Finance Company, at any time during the continuance of this contract, and the bonds to carry with them their pro rata proportion of stock.

This bid not to be binding unless the company makes contracts with responsible parties on the same terms and conditions as to receiving part pay in bonds for the completion of the entire canal.

All work to be done under the direction and to the satisfaction of the company's engineers.

Very truly, yours, C. P. TREAT.

JOHN R. BARTLETT, Esq.,
President Nicaragua Company, No. 2 Wall Street, New York City.

Colonel LUDLOW. These prices, you will observe, are prices which at that time were the only ones known to the public, namely, the prices of the report of 1890, which have been very materially modified and reduced in the estimates prepared by the company last summer at our request and which are printed for the first time in the report of the board. Mr. Treat had no knowledge of these revised prices. His proposition was based on 1890 prices. We asked Mr. Treat if he would be kind enough to make a proposition of the same kind in regard to the eastern division as well, because the proposition threw much light on the subject, and that he declined to do.

Mr. SHERMAN. I understand he declined to do that with the company?

Colonel LUDLOW. I do not know what he declined to do with the company. I understand what he told us. Of course we were not prying into other people's business, but what he said to us was he refused to have anything to do with the eastern division and did not care to take it.

Mr. DOOLITTLE. Do you know what position Mr. Bartlett occupied at the time?

Colonel LUDLOW. It is addressed to him as president of the Nicaragua Company. I do not know just what the proper designation would be; I think he was acting in charge of the canal company's office in New York. At any rate, the letter is addressed to him, and he was recognized as the person to make that to by Mr. Treat.

Mr. DOOLITTLE. I do not think I got any answer to the last question I asked you, and that is what elements enter into your estimate when you raised the cost of dredging of these harbors from 7 cents, the price paid in the United States, to 25 cents down there?

Colonel LUDLOW. I answered it in part.

Mr. DOOLITTLE. I should like to have an answer to that.

Colonel LUDLOW. I gave several very important elements which would enter into the increased cost down there, and with your permission I will go on and read this memorandum.

Mr. DOOLITTLE. I would rather for you not to do that. I would rather have an answer to that question in a concrete way.

Colonel LUDLOW. Well, I have done it.

Mr. DOOLITTLE. Will you repeat it, then?

Colonel LUDLOW. Very well. Item 1, taking the plant down there with the expense of transporting all the plant, and the expense of

engaging your service to go to the country and remain, the expense of having a larger force with you than you would use here in the United States, the additional compensation to be paid men for leaving their homes and going there—it is not to be considered that you could get them for the same wages—the increased expense of every item of living in that country by reason of the fact that your supplies must be transported from home and delivered there—your coal, your food, your clothing, your materials, and everything that you use in connection with that work—the necessity for creating, since they do not exist, all the shop and other facilities which you would need for the repair and maintenance of your plant. Those are the items which enter into the cost of work and for which the contractor will charge. Further, there is the abandonment of his plant on the completion of the work, or, in lieu thereof, transportation back again to the United States. The diminished value of labor in the tropics, a man's physical and mental inability to do as much work in that climate as he will do at home—that is to be charged for.

Mr. DOOLITTLE. Do you think that would furnish any considerable item in the last consideration you have mentioned in the work of these suction dredges at Greytown?

Colonel LUDLOW. Oh, yes; there is no question about it.

Mr. DOOLITTLE. Now, besides the erection of shops for repairs, keeping up the efficiency of the plant, and the returning of the dredge in case it was desirable to return it to the United States on the completion of the work, have you mentioned any items that would vary the expense down there from the expense in the United States? For instance, at Galveston the dredges are transported there, and on the Mississippi they are transported there, and when they are at work on the Puget Sound they are transported, say from San Francisco, as the Bower's dredger was. They are not unusual instances in carrying on this work even where only 7 cents per yard is charged. Is not that true?

Colonel LUDLOW. I do not understand that has anything to do with the comparison of work at 7 cents per cubic yard at Mobile, where they have been engaged there for the last ten or fifteen years——

Mr. DOOLITTLE. I understand dredges are brought from San Diego, Cal., to Puget Sound, a distance nearly as great as to Brito, and a distance greater than it would be from New Orleans over to Greytown, for the work there, and then the material is handled at 8 cents per cubic yard. That would not be very different from the conditions to be necessarily complied with in getting a dredger at work at Greytown?

Colonel LUDLOW. For that one item, perhaps not; but these are all items which enter into the cost, and if the contractor is going to take a plant from San Francisco to the Columbia River to do a job and dredge, whatever his price would be, the unit price would include the cost of getting the dredge there, would it not?

Mr. DOOLITTLE. Doubtless; but that would not make a difference of between 7 cents and 25 cents?

Colonel LUDLOW. You can not make him pay the cost of the job. If you hire him, you are going to pay for it, no matter how you figure it out. You understand, Mr. Doolittle, that the comparison you make with the Mobile dredge of 7 or 8 cents should be made with the 20-cent price which, in the judgment of the board, applies to the interior work.

Mr. STEWART. Would not the cheapness of the labor compensate for the additional cost of the plant?

Colonel LUDLOW. We thrashed that out pretty well. The board

substantially believes that the cost of a given piece of work in Nicaragua, taking it all around, as compared with a given piece of similar work in the United States, is just about double.

Mr. SHERMAN. May I ask you right there—you have enumerated certain elements which have entered into the increased cost in relation to dredging—do you know anything outside of the cost of erecting shops for the purpose of making any repairs and the transportation of the dredges back again to the United States; do you know any other elements than those which do not apply to every other part of this work than the dredging?

Colonel LUDLOW. I think it applies to every part of the work.

Mr. SHERMAN. Except those two items, every item you mention would apply to everything else as well as dredging?

Colonel LUDLOW. They are generally applicable.

Mr. SHERMAN. And I understand you to say that dredging costs four times as much as in the United States, and the general work only twice as much?

Colonel LUDLOW. We do not say the dredging costs four times as much; we say it costs double.

Mr. SHERMAN. But you estimate 25 cents, while at Mobile it is dredged at 7 cents, which is about four times as much?

Colonel LUDLOW. It is very easy to make a mistake. We stated at the outset that the price of 25 cents was an average price only. We estimate, of course, a very considerable increase for necessary dredging to be done at the entrance of the harbor, where the dredge would be exposed to the action of the sea and where frequently it will be interrupted, and we regard that work as much more costly, and put it at 40 cents per cubic yard, whereas we estimate the interior work to be done at 20 cents a yard and not at 25 cents a yard. Twenty-five cents makes the average price for the whole.

Mr. SHERMAN. I understand you.

Colonel LUDLOW. But the work that you are comparing at 7 and 8 cents should be with the 20-cent interior work not exposed to the sea.

Mr. SHERMAN. But 20 cents is more than twice 7?

Colonel LUDLOW. It is two and a half times.

Mr. SHERMAN. It is just as near three times 7 as you can get?

Colonel LUDLOW. Now, if you please, estimating the rough cost of the Nicaragua dredging as double, owing to the diminished value of labor and other considerations, you are working in a country where you have got to make your shops, create facilities, which you do not have to do at Galveston.

Mr. SHERMAN. Would that add 50 per cent more?

Colonel LUDLOW. It would add something.

Mr. SHERMAN. Would it add 50 per cent?

Colonel LUDLOW. The dredging will cost 20 cents there. The company's dredging costs 11 cents, on their own statement, which I do not in the least dispute.

Mr. SHERMAN. It was made when dredging cost more than it does to-day?

Colonel LUDLOW. That is the absolute net cost with very powerful dredges and the mere charges for daily maintenance, with no sinking fund, no depreciation charge, and no interest charge.

Mr. PATTERSON. And no cost charge of the dredging machine?

Colonel LUDLOW. And nothing charged to the cost of the plant at all, and no profit. That was absolutely the net cost of the dredging day by day until they piled out a certain mass of material, including

repairs to the dredges merely to keep them going for the time being. My colleague is good enough to remind me in connection with this 11-cent work that the material was simply moved a short distance, and it would have to be moved again.

Mr. DOOLITTLE. You said in your statement here you did not think with the methods now in use such dredges as those then used by the company could be advantageously used down there; that more modern dredges could be used. Now, with the modern methods, do you not think that work could be accomplished at less expense?

Colonel LUDLOW. What are modern methods?

Mr. DOOLITTLE. An engineer of your experience should know——

Colonel LUDLOW. I do know.

Mr. DOOLITTLE (continuing). Better than I do.

Colonel LUDLOW. But when you use the phrase I desire to know what interpretation I should put upon it.

Mr. DOOLITTLE. I am simply quoting what you said.

Colonel LUDLOW. I did not say anything about modern methods.

Mr. DOOLITTLE. But you said those dredges can not be advantageously used.

Colonel LUDLOW. And I do not think they can. I guess they were pretty good dredges in their day and they did an immense amount of work. They built a portion of the Panama Canal.

Mr. DOOLITTLE. Do you not think the expense would be much lessened by using more improved machinery for the handling of the material?

Colonel LUDLOW. Improved machinery always diminishes the cost, or should do so.

Mr. DOOLITTLE. Will you kindly answer that question?

Colonel LUDLOW. I do not know about putting Mr. Bate's dredge at work on that harbor; I would rather have it work and see what the actual net final result will be first.

Mr. DOOLITTLE. You know these machines have been working for years on the Pacific?

Colonel LUDLOW. I do not know that. I think it is a brand new and very superior element.

Mr. DOOLITTLE. Of course it is larger, but the same principle has been used.

Colonel LUDLOW. Oh, the principle of the hydraulic dredge?

Mr. DOOLITTLE. I mean of that character of hydraulic dredge?

Colonel LUDLOW. I was the first person in this country to put a hydraulic dredge in service pumping on an ocean-bar channel.

Mr. DOOLITTLE. I asked you a question and I have not an answer to it.

Colonel LUDLOW. What is it?

Mr. DOOLITTLE. Whether by using this improved machinery that the cost would not be very much decreased in the handling of this material?

Colonel LUDLOW. Below what?

Mr. DOOLITTLE. Below your estimate.

Colonel LUDLOW. I do not believe it would be safe to put it below our estimate.

Mr. DOOLITTLE. Below what it cost the company with their dredges?

Colonel LUDLOW. No, sir; that 11 cents price leaves out of consideration a great many things.

Mr. DOOLITTLE. I mean reckoning in all those elements?

Colonel LUDLOW. Reckoning in all those elements, we think that dredging in there is going to cost 20 cents per cubic yard in gold.

Mr. DOOLITTLE. Do you not believe, as an engineer, the cost would be very much decreased by making use of the best machinery which is used for this purpose to-day?

Colonel LUDLOW. Assuming that you use the most perfect machinery that exists to-day, I do not think it would be safe to estimate the cost of that dredging down there at less than 20 cents.

Mr. DOOLITTLE. If contractors who are reliable men stood ready to make a contract to remove that material at Greytown and on up the line of the canal at from 8 to 9 cents per cubic yard, would not that change your opinion in regard to the expense of that work?

Colonel LUDLOW. It might, after I had talked with them, and knew what they were talking about, but I would like to see their proposition first in writing; I do not want it orally.

Mr. STEWART. Is this opinion confirmed or modified by the letter of Mr. Treat you read a short while ago, or from actual computations?

Colonel LUDLOW. The letter we had last summer?

Mr. STEWART. Did that change your opinion in regard to the cost or control your opinion in any way?

Colonel LUDLOW. It guided our opinion a little.

Mr. STEWART. Your opinion is not formed from actual calculations, but from Mr. Treat's judgment?

Colonel LUDLOW. He made no proposition about this dredging at all. He refused to have anything to do with the dredging.

Mr. STEWART. That does not include the dredging?

Colonel LUDLOW. Not on the western division, and he refused to go further. His proposition refused to do dredging distinctly in terms.

Mr. DOOLITTLE. Do you know the actual cost per cubic yard that a dredge can be obtained to handle all the sand in Greytown harbor and canal for?

Colonel LUDLOW. No.

Mr. DOOLITTLE. You have not investigated to ascertain?

Colonel LUDLOW. We got all the information we could. We spent last summer investigating that, and we got experienced contractors to give us their estimate, too. All we could get hold of we used. We spent three months in the most extended correspondence and investigation, from 9 o'clock in the morning until 6 in the afternoon, and then to 12 at night.

Mr. DOOLITTLE. That is not an answer to my question. Do you know the actual cost per cubic yard that a dredge will handle all the sand in Greytown harbor and canal for?

Mr. CORLISS. Do you mean the dredge itself?

Mr. DOOLITTLE. Not at all.

Colonel LUDLOW. There is a whole lot of stuff in here which if you will read you will get a lot of information from; valuable, too.

Mr. DOOLITTLE. I have no doubt of its being valuable.

Colonel LUDLOW. You do not want me to read this?

Mr. DOOLITTLE. I do not want to take up time.

Colonel LUDLOW (reading):

The board obtained from Mr. E. T. Williams, of Duluth, who has had thirty years' experience in dredging and has employed during all this time a large plant, an expression of opinion as to the probable contract price for dredging at Greytown and Brito. His figures were 25 to 30 cents per cubic yard.

Mr. Williams's address is Duluth, if you want to investigate that.

Mr. DOOLITTLE. Do you know what profit he estimated for himself in that?

Colonel LUDLOW. Probably the contractor's profit.

Mr. DOOLITTLE. I asked you if he——

Colonel LUDLOW. I said probably the contractor's profit?

Mr. PATTERSON. What is the contractor's profit?

Colonel LUDLOW. About 20 per cent, and in such cases where he thought unusual expenses might be incurred he would stick up a little more. That is a fair profit. Now if you please I will go on a little further. You will observe that Mr. Williams gives the figures at from 25 to 30 cents per cubic yard. That was above ours, and we put in what we thought an extremely moderate estimate of 20 cents per cubic yard for the work. Now I will go on a little further.

The president of the Atlantic Dredging Company considered that 20 cents per cubic yard would be the lowest safe figure for the sheltered harbors, but that a larger figure than this should be used for canal excavation.

Now, that is the kind of advice we were getting.

Mr. DOOLITTLE. That is the best information you have on the subject of the cost of this dredging, then?

Colonel LUDLOW. What I have given and our own judgment.

Mr. PATTERSON. Go on; I would like to hear some more of that.

Colonel LUDLOW. There is a good deal here, and it is really very interesting. I can read it over very rapidly.

Mr. SHERMAN. Mr. Doolittle is asking a series of questions and——

Colonel LUDLOW. You are asking in regard to the cost of dredging, and I am telling you what we believe it to be and on what basis we estimate it.

Mr. PATTERSON. With all due respect you asked this gentleman a question and he was simply reading the data which entered into the formation of his judgment, and I think it is entirely proper for him to read all that data which entered into his judgment.

Mr. SHERMAN. So far as pertaining to that particular question.

Colonel LUDLOW. No; it is not all under the head of dredging.

Mr. PATTERSON. I do not think he ought to be cut off, and I call for all upon the subject.

Colonel LUDLOW. I will say these notes were prepared yesterday.

The CHAIRMAN. Complete your answer; when a question is asked you you have a right to answer it in your own way.

Mr. PATTERSON. I am interested in finding out now upon what he bases his judgment as to the cost of dredging, and now whatever data you have got there that reflects upon that question we desire to have laid before the committee; at least I do.

Mr. STEWART. But there is something else; you also want to know the attitude of the witness toward the canal, whether the witness is hostile to the project or not?

Mr. PATTERSON. That may enter the question.

Mr. STEWART. When you get a witness upon the stand you want to——

Colonel LUDLOW. Have you ever heard of a contractor who is hostile to a proposed big job of work?

Mr. STEWART. He might if he can not get the contract.

Mr. DOOLITTLE. I want to know what he makes up the statement from.

Colonel LUDLOW. The statement will speak for itself.

Mr. DOOLITTLE. From letters written to your board?

Colonel LUDLOW. From letters, information, data supplied by each member of the board, contributing jointly, information derived from private correspondence, telegrams, letters, and everything that we could get hold of.

Mr. STEWART. Did you invite these estimates?

Colonel LUDLOW. We sought them—wrote to gentlemen who might know, and if they could not come to see us we asked them to write us, so that we have a very extended correspondence. A good deal of it is official and a good deal of it verbal by interviews. We took the trouble to record all they told. We were as anxious to get the facts as anybody could be in regard to information given by responsible contractors.

Mr. DOOLITTLE. Of course, in these interviews with contractors and letters from them and all that kind of thing, I suppose you did not deem the subject considered by them as it would have been if the work had been in actual progress and they had been invited to make tenders for contract?

Mr. PATTERSON. Let us get down to the main question. There have been a great number of questions as to the cost of dredging, and I am anxious for Colonel Ludlow to lay before the committee the data on which he forms his judgment.

The CHAIRMAN. Colonel Ludlow has been informed by the Chair he should be protected in his wish to answer that question. If you desire to answer that question by submitting that data, you can do so.

Mr. DOOLITTLE. But at the same time I want to ascertain whether these men were making these prices as they would make them if they were entering into a contract or not?

The CHAIRMAN. That would be a proper line of inquiry after the Colonel has answered this question.

Mr. DOOLITTLE. No, sir; it would be proper before.

Colonel LUDLOW. I will state this, if you please, so as to give what might be considered the local atmosphere of our inquiry. We were three responsible engineers appointed by the Government to make an investigation of a very important subject. We do not believe any contractor or any other man came in with any misunderstanding at all of our relation to the matter further than that we wanted to get the most accurate and best authenticated information we could, and I do not doubt in the least these gentlemen with whom we conferred really used their best judgment in furnishing us with the information. They could not have any question as to our purpose in asking and they had no other motive in giving it.

Furthermore, I will say in regard to this material which I have here, we spent a good deal of time yesterday in going over the large mass of minor data, and it was prepared at the express request of Mr. Doolittle, who advised me that that would be the nature of the investigation or inquiry to-day, and requested me to prepare myself for it. That, of course, includes the other members of the board, and we have been in conference upon the subject. It is not very long, really.

Mr. SHERMAN. I do not think anybody wants to shut you off. Colonel Patterson misunderstood me, and I thought you had finished with that particular line, and if you have not it is no matter.

Colonel LUDLOW. I will read as rapidly as I can, if you please. Of course you will understand this was hastily thrown together and there has been no opportunity to revise it except to look over and correct some obvious errors. "Unit prices" is the heading of the paper.

Dredging: The cost of dredging in Bay Lake channel, between lakes Superior and Huron, in soft material (soft clay and sand), and in large amounts, averaged in the last five years about 15 cents per cubic yard.

The prices entered in the contracts are apparently lower, because payment is made at half rates for material excavated outside the cross section, if not more than 2 feet of excess depth. Dividing the total amount paid under the contract by the total number of cubic yards excavated from the canal prism, a quotient of 15 cents *per cubic yard* is obtained.

The largest bulk contract for dredging so far placed in the United States, was from the Delaware River at Philadelphia, where the unit price is 14.2 cents.

While the board was preparing its report, a visit was made to Greenwich, Conn., where a dredge was employed in dredging mud and soft clay, which was discharged through a pipe an average distance of a quarter of a mile, the contract price being 20 cents per cubic yard. This was a private contract.

The board obtained from Mr. E. T. Williams, of Duluth, who has had thirty years' experience in dredging, and has employed during all this time a large plant, an expression of opinion as to the probable contract price for dredging at Greytown and Brito. His figures were 25 to 30 cents per cubic yard.

The president of the American Contract and Dredging Company (?) considered that 20 cents per cubic yard would be the lowest safe figure for the harbors in sheltered places, but that a larger figure than this should be used for canal excavations.

No responsible engineer would consider himself justified in adopting unit prices materially less than those paid on work executed within a recent period. The adoption of the price based on the performance of the Bates hydraulic dredge, would be at the present time unjustifiable. This machine has a record obtained from a mean of ten official tests of a little over 4,000 cubic yards per hour. These ten tests occupied in all less than ten minutes, and consisted in filling tanks of known capacity, the tanks being filled ordinarily in less than one minute. Colonel Flad, well known to civil engineers, and a member of the Mississippi River Commission, states, in a recent letter, that the machine was never worked for six hours without breaking down, and that he is led to believe that its capacity for actual work would not exceed 1,600 cubic yards per hour. A safe estimate of the capacity of this machine can not be made until after at least a full season's work.

Mr. DOOLITTLE. I would like to ask about that. That may be true of Mississippi dredging, but the dredges used on the Mississippi River have been used for years——

Colonel LUDLOW. Right on the Potomac Flats, too.

Mr. DOOLITTLE. So it is only the greater capacity of the dredge which has to be tested?

Colonel LUDLOW. And practically the superior economy of its performance that remains to be ascertained, because it is not mere quantity. It is what you have to pay for your work, after all. If a big dredge will do it cheaper, then it is good, but if a little one will do it more cheaply, that is the one you want.

The price for dredging at Mobile was the lowest in the United States to the knowledge of the board. The board would not be justified in basing unit prices on this single example differing so widely from the price of other work the conditions of which it is entirely familiar with. In any case, the Mobile price could only apply to work of an entirely similar character, and the only comparison could therefore be made with reference to the dredging in Lake Nicaragua, where the conditions do present a considerable similarity as pointed out in the board's report. It is to be remembered, however, that in the case of Lake Nicaragua provision must be made to prevent the adjacent soft material from flowing into the cut as made and does not believe that even Mr. Bates's magnificent dredge, assuming the full capacity claimed for it, would be able, without special engineering constructions or devices of some kind, to make the channel through the 14 miles of soft mud, varying from pea soup to stiff, through which the lake channel will have to be cut. The board believes that if this dredge should pump a channel from the lake shore to the 39-foot contour by the time it had terminated its 14 miles of cut the earlier excavation could not be detected.

No provision is made in the estimates for protecting the sides of the cut from inflow, and, as the board suggests, this will have to be done either by sheet-piling (an extraordinarily expensive method) or by following the German precedent of building under-water walls of stiff material, which would sink through the softer material, as was done in the case of the Kiel Canal, whose longitudinal sand dams were built prior to the endeavor to excavate the channel between them. At Lake Nicaragua there is no sand available for this purpose, and dependence must be placed upon the clay to be excavated, probably from the cut itself, which may or may not be of sufficient coherence to answer the purpose, and for which the hydraulic dredge is totally unavailable. Whatever the cost of constructing these dams may be, it must be added to the cost of excavation by increasing the unit price.

In order to give the committee a clear idea of the nature of this soft mud, it may be stated that in taking soundings with a sounding pole, the only method by which the depth of water could be ascertained, was by noting the length of rod covered with mud after withdrawing it from the water.

On the trip down the lake, after the completion of the inspection of the western division, the lake steamer plowed through this mud, reducing her speed to two or three miles per hour, but not stopping the movement of the boat. Her draft was about 7 feet.

Mr. DOOLITTLE. That would be navigating in mud?
Colonel LUDLOW. Yes; it is lovely for it.
Mr. DOOLITTLE. Navigation in mud is a new factor.
Colonel LUDLOW. You will find many new things down there.

Referring to the unit price for work executed in Hay Lake Channel, it is to be noted that the dredging was not only through material readily excavated, but that the place for depositing the dredged materials was in the near vicinity. The unit price assumed by the board for interior dredging in the harbors of Greytown and Brito was 20 cents per cubic yard, although by reason of allowing a greater figure for dredging in the harbor entrances exposed to the action of the sea, the average price assumed was 25 cents. The comparison therefore, between the unit price at Hay Lake Channel and the board's assumed price is between 15 and 20 cents, and the increase in sums for the Nicaragua work are certainly moderate in amount when the conditions of the two localities are considered. In fixing this as their price, the board took into consideration the probable use of more powerful machinery and consequent reduction in unit cost. Furthermore, its unit cost was, to a certain extent, suggested by the actual experience of the canal company, which found its net cost 11 cents with powerful dredges, allowing nothing for wear and tear, depreciation of plant, interest on outlay, profit, or any other item than the ordinary daily current repairs of the apparatus.

Furthermore, the material excavated was not deposited outside the limits of the work, and as deposited must later be moved a second time in order to get it a proper distance from the excavation. Furthermore, that portion of the work done by the company was absolutely the easiest and cheapest of all the work there is to be done on the canal. It was clear sand, which presently runs out and becomes more or less mixed with clay, and later disappears altogether when passing from Greytown Harbor toward the east divide. The company could argue that this work costing 11 cents furnishes a datum for all the other work in that vicinity, including the clay excavation and the dredging at the entrance, where the operations will be affected by the sea. If the actual cost of maintenance of plant were added to the company's figures, it would increase the price $1 per cubic yard, because the plant is now utterly valueless. This is, of course, an excessive allowance under ordinary conditions; but the plant account would, in any case, be a very large share of the total cost of the unit price.

If the hydraulic dredge were to be used for excavation in the canal section near Greytown Harbor, it would be necessary, first, to remove the surface material, including stumps, logs, roots, etc., with some other plant, before the hydraulic dredge could be safely operated. When proceeding upward from the divide, entering the region where material consists largely of mud, the proportion of submerged logs and stumps would undoubtedly be much greater than where dredging was done in the vicinity of Greytown Harbor.

The conditions at Brito are, if anything, less favorable than at Greytown; while the rainfall is less, the swell from the ocean would be much greater.

It is impossible to say what may be the essentials with reference to the dredging of the San Juan River, the nature of the river bed, so far as the distribution of the materials is concerned and their depth, being practically unknown. The lead-line indications make it probable that it consists largely, in certain parts, of bowlders and other materials impossible to dredge. In any case, it is to be observed that the disposition to be made of the dredgings from the river is a difficult matter, and there is no other way, at this time, of taking this difficulty into account than to leave the unit price with a moderate allowance for covering it. It may be observed that the price adopted by the board for this work is the same as that used by the company in their latest published report. It should be clearly understood that nothing later than the report of 1890, in the nature of estimates, has been accessible to the public, and that when engineers and contractors are represented as accepting the company's estimates, the figures of 1890 are the ones to which they refer, and not the revised figures of 1895 prepared at the request of the board.

Inasmuch as all the machinery, of whatever description, to be used on this work must be imported from a distance, in an estimate in which all charges for transportation and delivery of plant are omitted, there are no means of meeting these expenses (which, beyond doubt, any contractor would charge for) except to enter it as a part of the unit price of the work, and a similar allowance either for the return or the abandonment of the plant on completion of the work. The propriety of charging the work with the entire cost of the plant is denied by the chief engineer (p. 87 of the hearings) and admitted (p. 88).

Colonel LUDLOW. With your permission, I will read that. It is a rather important point, because it is an item of cost. At the bottom of page 81 Mr. Menocal in his paper, not his oral testimony, states:

There seems to be no good reason for the statement that the machinery used will be of but little value after the construction of the canal, that hardly any of it will be worth removal, and its entire cost would therefore be charged to canal construction, making the plant charge higher than usual. With the canal finished and opened to traffic, and a railroad parallel to it, there is no reason why the plant should not be transported to any part of the world where there may be a demand for it at the same or less cost of transportation than in the United States.

The dredging plant used in Panama for several years was transferred to Greytown in good working order, and the whole plant of the Panama Canal could have been shipped to Nicaragua without much trouble and at small cost.

He does not note that one of the dredges from Panama was sunk on the route and was lost.

Now, at the top of page 88 he says:

However, it is quite likely that contractors in bidding for work on the canal would figure but little on future returns from the sale of the plant used in the work, and it may well be doubted that the contractors for the Chicago drainage canal, with the experience gained at Suez and Manchester and other similar works, expect any proceeds on the completion of their contracts from the sale of the special machinery and other appliances used in the works, except as scrap.

Mr. DOOLITTLE. Of course that is true, if the machinery is worn out?

Colonel LUDLOW. It is whether there is any good reason to believe the machinery would be of any value, and on the next page he says it will not be.

Mr. DOOLITTLE. I do not see anything inconsistent in that at all. If it is worn out, it will be valueless, and the other will not be?

Colonel LUDLOW. We charge the cost of the plant to the work, and he is objecting on page 87 to that, while on page 88 he admits it.

The current cost of dredging at the Suez Canal varies from a franc to a franc and a half—say 20 to 30 cents—this figure applying to quantities of about a million cubic meters annually for maintenance only, and another probably equal amount for the widening.

The dredging at the Manchester Canal was 9 pence half penny—say 19 cents—per cubic yard when landed, and 7 pence—say 14 cents—when towed out to sea.

Mr. STEWART. They do not have the best machinery, do they?

Colonel LUDLOW. They are pretty good machinists.

Mr. STEWART. They have not got the Bates dredging machines. You do not consider them up to date in reference to dredging machinery?

Colonel LUDLOW. They are pretty practical kind of people. They have all kinds of dredges that anybody has. There are great seagoing dredges built on the Clyde, which go out to Australia. They have sent out great dredges as far as Australia.

Mr. STEWART. But American patterns they get from America, they have not their own designs, and——

Colonel LUDLOW. Oh, yes; they do not use dredges from this country. When the Nicaragua Canal Company wanted a dredge it ordered one from Glasgow.

The cost at this point is obviously less than it would be for similar work in the United States on account of less cost of plant and lower rate of wages. In constructing the Manchester Canal the cost of dredging soft material varied from 25 to 37½ cents, and for material requiring blasting from $1 to $2.50 per cubic yard.

Earth excavations above water, western division: In the western division, where the rainfall (though much greater than in the United States) is much less than in the eastern division, the cost of the work is more nearly comparable to that of the United States.

The average contract price of earth excavation from the Chicago Drainage Canal is not far from 30 cents per cubic yard, or for clay alone about 25 cents per cubic

yard. This work was executed mainly during the summer, because it could not be profitably carried on during the unfavorable weather of winter. While the work was being executed the banks of the canal were formed, making it easier to remove the plant for wasting the spoil, and, as noted by Mr. Bates in his interesting testimony, experience on the canal demonstrated that the two lines of railroad running on either side of the canal were of inestimable service. This and the proximity to the almost limitless mechanical resources of Chicago, together with the extremely low price of fuel obtained from the vast coal fields of northern Illinois in the immediate vicinity, delivered at $1.75 per ton, rendered the cost much less than that of similar work in Nicaragua. The addition of 60 per cent to the cost of work at Chicago to meet the comparatively unfavorable conditions of climate, rainfall, cost of plant, fuel, and all other supplies is an extremely moderate one. The figure adopted by the board, 40 cents per cubic yard, is the one which appears in the company's schedule of 1890, and is the one adopted by Mr. Treat in his proposal to the company, although under certain conditions which practically amount to a large increase. In its recent estimate the company has reduced this unit figure to 35 cents for earth excavation from the canal, but retained it for excavation at locks.

It is usual, in receiving proposals for lock excavation, to ask for a separate price for pumping. In the present case the cost of all auxiliary work is included in the unit price for excavation, except in the case of the tide lock, where specific allowance is made. In this connection it may be well to note that, anticipating the difficulty involving the construction of lock pits under heavy rainfall, the chief engineer, on page 89, states that it can be easily met by the construction of temporary sheds over the lock sites, but has not apparently undertaken to make an estimate of what it will cost to put under roof an area of 800 feet long by perhaps 100 or 150 feet in width.

Excavation above water, eastern division: It would be difficult to imagine more unfavorable conditions for excavating clay than exist in the eastern division under the tremendous rainfall of nearly 300 inches per year.

The work in the east divide is through a continuous series of hills, and after the removal of the clay the profile taken on the surface of the rock will be only a little less hilly than before. The difficulty of handling plant for the removal of material will be easily appreciated, and the addition of 50 per cent to the price adopted for the western division is not excessive. This unit price includes the cost of disposing of the flow of the waters of the Deseado and Limpio, which cross the canal line frequently, and during the heavy rains have large volumes of water. The importance of this is very great, and the entire lack of data as to the actual volume renders it impossible for an engineer or contractor to estimate, even approximately, the cost of doing this. The rains, which occur nearly every day, would cause the entire suspension of work of the same character anywhere in the United States. In ordinary work an inch of rain would involve temporary suspension and resort to pumping to clear the site.

The cost of earth excavation for the lock now in use at the St. Marys Falls Canal was over $1 per cubic yard, and the contract was profitable. The contract price for the lock about to be opened was 43 cents per cubic yard, and the contractors were in financial difficulty before the completion of the work.

Excavation at site of embankment: The cost of this is estimated by the company at $1 per cubic yard and by the board at $1.50. The figure adopted by the board was obtained by consultation with a very competent contractor, Mr. Arthur McMullen, of New York, a portion of this unit price being made to include the necessary cost of cutting off the mud bottoms above and below the site to prevent inflow into the excavation, a cheap and ready method of doing this being suggested as the sinking of rough timber cribs, filled with stone, into the soft bottom.

Rock excavation, western division: The company's price for rock excavation in the western division, according to the schedule of 1890, is $1.25 per cubic yard, reduced to $1 in their estimate of 1895, published for the first time in the report of the board. The board has adopted the company's price of 1890.

The price adopted by Mr. Treat was $1.25, the same as in the schedule of 1890 and in the estimate of the board, but with certain conditions, which, as before offered with reference to the price of earth excavation, made a material increase.

The conditions under which this work would be done in the western division are much less favorable than at the Chicago Drainage Canal, for reasons before given, and for the additional reason that the material is largely hard, volcanic rock, which breaks up much less readily, and where the cost of making the sides of the canal smooth, so as to be practicable for the passage of vessels, would be considerably greater.

On the eastern division the conditions are less favorable in every way, and the increase of 50 per cent per cubic yard is a very moderate allowance therefor. The economic methods developed at the Chicago Drainage Canal will be applicable here to a very small extent only. The average contract price of rock excavation at the Chicago Drainage Canal is about 75 cents per cubic yard. The rock is a soft lime-

stone, horizontally stratified, which can be drilled easily, which breaks up well with explosives, and in which the sides can be made smooth cheaply by channeling. The ground is level, the rock being generally found at the surface, and the plant for the removal of the material is easily handled, to say nothing of the unusual and extraordinary facilities furnished by railways for furnishing access to the work.

The contract price for the large amount of rock excavation at the Jerome Park reservoir, New York City, placed under contract for the last year, is about 80 cents per cubic yard. The rock is a laminated gneiss, which would be somewhat more difficult to drill and blast than the limestone in the Chicago Drainage Canal, and less so than the so-called conglomerate on the east divide.

Earth embankments: The price adopted by the board and that adopted by the company are the same, except that it was found that the excavation in the east divide would not supply a sufficient amount of clay for the embankments in the San Francisco Basin. An addition was therefore made to cover the cost of excavating and loading on cars the required additional material. The company made no allowance for this indispensable item of cost.

By building considerable additional railroad line a portion of this required material might come from the several short excavations for the canal in the San Francisco Basin, but the cost would probably be at least as much as by the method considered by the board.

The estimate for the San Francisco division in 1890 is 3,250,000 cubic yards at 30 cents. The company's 1895 estimate is over 6,000,000 cubic yards, using the same unit price, without noting the fact that the practical doubling of the quantity will necessitate borrowing to build the embankments. The board found it absolutely necessary to make an increased allowance to meet this additional cost.

Rock excavation under water: The main body of this work must be done in the upper 30 miles of the San Juan River. The company's unit price for this in 1890 is $5, which they reduce to $3 in their revised estimate of 1895.

The cost of this class of work has been greatly reduced in recent years. The larger part of the work has been done by Mr. Charles F. Dunbar, of Buffalo, who is the inventor of a device by which a large reduction of cost has been effected. Considering Mr. Dunbar the highest living authority on this question, he was consulted by the board, and suggested the unit price of $5 to $6 per cubic yard, and the board adopted the lower of his figures. Mr. Dunbar has recently authorized the use of his name in this connection.

The low price paid for this class of work under current contracts on St. Marys River, Michigan, viz, $2.43 per cubic yard, is not a criterion for the cost of work in Nicaragua. The rock in the St. Marys River is horizontally stratified limestone, more easily blasted and dredged. The work is done in a more favorable climate and in the neighborhood of all facilities for the supply and maintenance of plant.

In adopting the lowest figure named by Mr. Dunbar for work of this class, the board has gone to the lowest limit which it believed to be permissible under the circumstances, particularly as in the case of the St. Marys River the depth of excavation is only 22 feet, while in the San Juan River it is about 28 feet, and the proper disposition to be made of the material arises as a question for careful consideration and may involve special arrangements for guiding the flow of the stream and the maintenance of the channel depth.

Lock construction: It is to be noted that the company's project makes use of no other material in the construction of the locks than concrete. If the estimates are to be followed in this respect, the various canal publications and statements indicate the use of ashler masonry, of iron, and other material, which, however, are lacking from the estimates, which provide only for concrete at $6 per cubic yard. For example, Mr. Menocal's Chicago paper, pages 33 and 34, stated the body of the lock is to be of concrete, with cut stones in the miter sills, the hollow quoins, and such angles as give protection from shocks. Of all this, nothing appears in the estimates.

The board has found difficulty in understanding what the company really proposed, as there are absolutely no detailed or construction drawings of any kind, and in forming its own estimate and computing the cost of these locks, the board was forced to prepare for its own use preliminary drawings of this kind.

It is evident that the use of a resisting and massive material is absolutely necessary in lock construction, to take up the shock and percussion due to the passage of large vessels, and the practice is universal of using materials of this kind, either of a very high order of brick masonry or the use of solid cut stone; limestone or granite of the toughest and most resisting kind.

The use of these materials is not only in connection with the movement of vessels, but also to insure the solidity of anchoring for the gates and other appliances in connection with the operation of the lock.

The company disregards all these considerations, and uses exclusively a concrete in the proportions, as stated by the chief engineer, of 1 volume of cement, 2 of sand, and 5 of broken stone, at an estimated cost of $6 per cubic yard.

Under the conditions existing in Nicaragua, where there appears to be an utter absence of stone suitable for ashler masonry, the use of concrete for the main walls of the lock is perhaps permissible, and was contemplated in the estimates of the board. Greater strength should be given to exposed angles, by the introduction of first-class stonework. The estimate of the board covers the cost of this material for the hollow quoins and portions of the walls in which the posts of the gates will turn. This is certainly the minimum amount of this material which can be used, and is much less than any other known construction. Granite should be used for this purpose, and would have to be transported from abroad. The board's unit is $60 per cubic yard, which, of course, includes the expensive stone cutting necessary to adapt it to its uses, and the special plant required for laying it in place.

It would probably be judicious to use the same class of material at the other exposed angles and for the miter sills, as suggested by the chief engineer in his Chicago paper, which were not provided for in his estimates.

In addition to this, in view of the unprecedented dimensions of the locks as proposed, and the uncertain nature of the material in which, of necessity, the locks must rest, and the possibility of the variation in the nature and supporting power of this material within the limits of the lock area.

The board, while making free use of concrete, has considered the possible necessity of strengthening the lower portions of these structures by steel beams embedded in the concrete. This is especially important in view of the tendency of the middle of the lock bottom to rise in consequence of the great upward pressure from below, which can not be counterbalanced by the lock content.

It appeared to the board that another large addition to the estimates was necessary to provide protection to the inner surfaces of the culverts for the admission to, or discharge of, water from the lock. This might be provided by a lining of hard brick, or by a metal lining. The estimates of the board provide for the latter.

Concrete: The board's estimate for the cost of concrete is based on the following particulars: The price of cement was furnished by the New York agent of one of the principal German manufactories, for delivery at Greytown and Brito. The prices were $2.30 per barrel, f. o. b., Greytown, and $2.42, f. o. b., Brito. The board endeavored to make a careful estimate for unloading, landing, transporting, and storing this material, with a just allowance for waste in that damp climate, resulting in the unit price of $2.60 at the site of the work on either slope.

The sand must be obtained from the sea beach, and the estimated cost at the site of the work is 55 cents on the eastern slope and 50 cents on the western slope, for collection, transportation, and delivery.

The cost of the sand at the St. Marys Falls Canal lock has been somewhat more than 40 cents per cubic yard, all the conditions being less expensive, the point of collection being nearer, and the expense of handling considerably less. The board's estimate is very low comparatively.

The estimated cost of broken stone, delivered at the site of the work, is $1 on the Atlantic Slope and 90 cents on the Pacific Slope. This includes the cost of storing and loading the stone from the spoil banks, transporting it to the site of the work, unloading, and crushing. The cost for the same item at the St. Marys Falls Canal has been between 80 and 90 cents per cubic yard on the work just completed, the stone being obtained within 1,000 feet of the site of the work.

Basing its estimate per 1 cubic yard of concrete on this data, and using the proportions specified by the chief engineer of the canal company, we have the following table of cost of the work:

(1) Eastern division:

1.47 barrels of cement, at $2.60	$3.82
.36 cubic yards of sand, at 55 cents	.20
.91 cubic yards of stone, at $1	.91
Timber forms (material and labor)	1.00
Plant	.50
Labor (mixing and placing)	1.50
Total	7.93
Contractor's profit (20 per cent)	1.59
Cost for 1 cubic yard of concrete	9.52

Price adopted by the board, $9.50.

(2) Western division:

The corresponding total for the western division, including 20 per cent for contractor's profit, is $9.08, the difference being due to slightly less cost of sand and stone and to better climatic conditions. The price adopted by the board for the western division is $9. It will be observed that the board in both cases adopted as its unit price a figure actually less than the detailed estimate indicated.

As stated in the report of the board, the cost of concrete of the same proportions used in the locks of the Hennepin Canal, between Chicago and the Mississippi River, was $9 per cubic yard. This was done by hired labor, and includes no allowance whatever for profit. This cost is greater than the usual cost of concrete of these proportions in the United States, and is due to the great care and thoroughness with which the work was done.

The board does not believe that this price, though it represents an unusually large one in the United States, can by any possibility be safely reduced, for the totally different conditions, much more difficult, under which the similar work must be done in Nicaragua.

The cost of concrete of the same proportions under current contracts at the Brooklyn Navy-Yard was $7 (!) per cubic yard.

The low cost of concrete ($4.57 per cubic yard) in the locks on the Coosa River, in Alabama, referred to by the chief engineer, is due, first, to the proportions used, which are 1 volume of cement, 3 of sand, and 5½ of broken stone, thereby greatly reducing the amount of the expensive ingredient, cement; second, to the unusually low price of labor in the particular section where this work was done, viz, $1 per day; third, for the low cost of the staging and moules, which were made of timber, the work being located in the heart of the southern pine region; fourth, the omission of any charge for the use of the plant; and fifth, the absence of any allowance for profit, the work being done directly by the Government. With these allowances the figures will be corroborative of those of the board.

These lock constructions, while the exact dimensions are not at the moment in the hands of the board, were of moderate dimensions, and are in no sense comparable to the tremendous constructions estimated for in Nicaragua.

The San Mateo Dam, in California, a very large construction of concrete, cost per cubic yard $8, the proportions used being 1 volume of cement, 2 volumes of sand, and 6 volumes of broken stone.

The Betaloo Dam, in Australia, contains upward of 60,000 cubic yards of concrete, costing $10.16 per cubic yard, labor being $1.68 per day.

The large amount of concrete used at the Cascade locks in Oregon cost $8 per cubic yard, with no allowance for profit, the work being done directly by the Government. The proportions for a large part of this work were 1 volume of cement, 3 volumes of sand, and 6 volumes of broken stone. For another large portion 1 volume of cement, 4 volumes of sand, and 8 volumes of broken stone. A small proportion of the total amount was composed of 1 volume of cement, 2 volumes of sand, and 4 volumes of broken stone, the average containing a smaller proportion of cement than is proposed for the Nicaragua Canal.

The cost of concrete in San Francisco Harbor, in proportions of 1, 3, and 8, was $5.22, with no allowance for plant or profit. This concrete contained relatively a small proportion of cement.

Mr. Wheeler, an engineer employed on the St. Marys lock, in his article on lock construction in the Engineering News of June 2, 1893, makes a total estimate for six locks at Nicaragua, system of locks of 36 feet 7 inches, the total of which amounts to $1,000,000 for each lock at United States prices, and on the assumption that the lock is to be built on a rock foundation. Starting with this figure of $1,000,000 for the lock itself, adding $400,000 for additional concrete, to constitute a lock foundation in lieu of the rock considered by Mr. Wheeler, makes $1,400,000 at United States prices. This total needs translation into Nicaragua prices, for which an additional allowance of not less than 50 per cent should be made, making the Nicaragua cost of the lock, exclusive of excavation of the lock site, $2,100,000, making a total of $6,000,000 for the three locks of the eastern division, with which may be compared the total in the company's estimate of $3,236,000 which the board believes should be increased by the substitution of four locks for three, with a corresponding total of $7,000,000 as the additional allowance of 50 per cent for different conditions in Nicaragua may easily be increased.

Canal and channel dimensions (locks): The 1890 estimates were based upon a lock width of 70 feet. The next announcement of the width occurred in the chief engineer's Chicago paper, in which he states that the width has been increased to 80 feet. In his recent testimony, on page 73, he finds no objection to this increase from 70 to 80 feet, except the cost. On page 86, referring to paragraph 12 of the board's report, in which they expressed the belief that all locks should have a width of not less than 80 feet, if it be intended to provide for the passage of war vessels, the chief engineer states that this suggestion is objectionable, and he regards it unnecessary to charge the enterprise with an excess of commercial capacity, in order to permit of the passage of a few war vessels. This declaration, made in his Chicago paper in 1893, and repeated statements to the same effect in the publications of the company.

The board adheres to its belief that 80 feet should be regarded as a minimum width, in view of the use by the United States Government of the canal to facilitate the movements of its Navy and the control of the work in case of war.

On pages 58 and 65 of his testimony the chief engineer states the dimensions of the Suez Canal. He gives the depth at 26 feet and the width as less than 100 feet. As a matter of fact, the least depth in the Suez Canal at this time is 27 feet 10 inches, and for the most part it is 29 feet 6 inches, and the administration proposes an ultimate depth of 32 feet 10 inches.

The canal, as constructed, was 72 feet wide, with passing places excavated at intervals in the bank. These passing places have since been eliminated by the widening of the canal to 110 feet, this widening having been completed with the exception of 10 or 12 miles. It is to be noted, however, that even with this widening, vessels traversing the Suez Canal are not permitted to pass each other under way. When two vessels meet, one or the other must come to the bank and tie up while the other moves safely by.

In order to provide for the free navigation of the canal, and expedite the movements of ships by rendering it unnecessary for them to stop, the administration, in connection with the increased depth to 32 feet 10 inches, provides for a widening to 216 feet on the straight stretches of the canal, and on curves of 242 feet, these widths being measured on the bottom of the canal. With these widths the company believe that the navigation will be free and unobstructed.

These dimensions are to be compared with the proposed dimensions of the Nicaragua Canal, with bottom widths in various sections ranging from 120 feet in the sea-level portions to 100 feet, with vertical sides in the rock portions, and 80 feet at several minor isolated sections. The depth is stated as about 30 feet on the same level, except in the river, where for 30 miles it is to be 28 feet. From these depths, however, as has been previously noticed, must be deducted the variation from what the chief engineer calls the average summit level, to provide for the vertical oscillations of the lake surface. He estimated these oscillations in one case at 3 feet, in another portion of his testimony at 4 feet, and in another place states that the range of the lake has been noted as 10 feet.

The board has found reason to believe that the lake has varied so much as 14 feet, but no systematic observations have ever been made to determine the lake regimen, upon which depends that of the river.

With a range of 4 feet, the 28-foot river channel becomes but a 26-foot channel, in which, allowing for 2 feet as a minimum below the keel of the vessel, nothing deeper than a 24-foot ship can pass. Should this range amount to so much as 5 feet, the navigable depth becomes 23½ feet. If it be found impossible to control the oscillations of the lake within less than 10 feet, the reduction in depth in the channel will be 5 feet, and nothing deeper than a 21-foot ship can pass. In three of these cases the channel would be impassable for war ships, as well as for the increasing dimensions of trading vessels, which experience has shown can be more economically run with large dimensions than with smaller.

In the case of the Suez Canal, with the minimum depth of 27 feet 10 inches now existing the maximum draft of vessels permitted in the sandy bed of that waterway is 25 feet 7 inches, leaving 2 feet and 3 inches between the keel of the vessel and the sand bottom.

Objection is made to the board's suggestion that the width of the deepened channel in the river should be increased from 125 feet, as the company proposes, to not less than 250 feet, with additional widening in the bends, and the chief engineer contends that in our consideration of this subject we have been misled by our acquaintance with the particulars of the lake navigation, with which, apparently, he believes that of the Nicaragua Canal is not justly comparable.

As stated in the board's report, the minimum width for the river and lake channels on the lakes is 300 feet, increased in places to 500 and 600 and even 800 feet. It should be observed that these dimensions were fixed, not recently, but many years before the lake traffic had attained its present proportions, when the vessels were much smaller than now, of less draft, and therefore more manageable in a narrow channel, and as a whole very much less than the traffic which it is proposed to provide for in the case of the Nicaragua Canal.

The St. Clair Falls Canal, which forms the exit from the St. Clair River into the lake, a work designed and executed thirty or forty years ago, has a width between banks, which are laid out straight and built of timber, of 295 feet, and between these vessels are restricted to a speed of 5 (!) miles an hour, and are not permitted to overtake each other. It is quite certain that in the case of the Lake Nicaragua channel, built as proposed by the company, without constructed banks, no less width than 300 feet can by any possibility be estimated for, and the maintenance of this or any navigable width will require the continual use of a dredging machine for maintenance.

The company, in its reference to this, obscures the subject by calling these river channels "canal," with which, as a matter of fact, a deepened river channel without banks can not, in this respect be compared, and it is to be observed that the width of river channel proposed by the board is little in excess of that which the intel-

ligent and experienced management of the Suez Canal believe to be necessary for an inclosed channel with soft bottom and well defined-banks and no current.

With reference to the width of the lake channel which the company now and again terms canal, the board believes that it has adopted an equally sound and conservative view, nor is it believed that on Lake Nicaragua, or in any similar situation, a channel of 14 miles can be laid out in the open lake through the material which it is known forms the bottom of the lake with any less dimensions than those which the board has recommended.

The material has been described as soft mud, ranging from a thick pea soup at the top to stiffer material below, and it is not believed, as before stated, that even Mr. Bates's magnificent hydraulic construction could make a cut through that 14 miles and be able to find it after it had been done.

The most recent proposition in this country for providing an exit for commerce by water from the lakes to the sea, it may be noted, projects a channel with a minimum width of 300 feet.

NICARAGUA CANAL, COMPARISON OF ESTIMATES.

Company's estimate of 1895, for low-level line, with board's estimate of 1895: The increase in the board's estimate arises, first, from correction of errors in company's estimate; second, from provision for new work, such as stone-pitching sites of the canal in certain places, railroad track and trestle around Greytown Harbor, wharves, machine shop, and workhouse at terminal harbors, provision for sheet piling for lock foundations, granite quoins for locks, steel in foundations and culverts, anchors for lock gates, back filling at locks, railroad sidings, stations, turntables, etc., abutments for the Ochoa Dam, sheet piling under earth fill of same, partial diversion of San Juan River; third, other items of increase of quantities; and, fourth, increase of unit prices.

Summary for entire canal.

	Amount without contingency allowance.	Amount, including 20 per cent contingencies.
Correction of errors in company's estimate	$3,579,693.80	$4,295,632.56
New work	6,133,160.00	7,359,792.00
Other increase of quantities	13,525,108.45	16,230,130.14
Increase of unit prices	24,744,731.85	29,693,678.22
Separate allowance for hospital, management, and engineering	5,000,000.00	6,000,000.00
Total increase	52,982,694.10	63,579,232.92
Company's estimate (low-level line)	58,244,717.00	69,893,660.00
	111,227,411.00	133,472,893.00

If the schedule of prices of 1890 be applied to the canal company's quantities of 1895, the amount of the estimate will be $78,583,169.

If the company's schedule of prices of 1890 be applied to the board's quantities, the amount will be	$117,245,792
Board's quantities at board's prices	133,472,893
Difference between company's schedule of 1890 and board's schedule makes an increase of	16,127,101

Correction of errors in computation in company's estimate, company's schedule of 1890 applied.

San Juan River:		
1,313,100 cubic yards dredging, at 30 cents		$393,930.00
1,025,387 cubic yards rock excavation under water		5,126,935.00
		5,520,865.00
Lake Nicaragua:		
667,924 cubic yards dredging, at 20 cents	$133,584.80	
13,891 cubic yards rock excavation under water, at $5.	69,455.00	
		203,039.80
		5,723,904.80
25 per cent		1,430,976.24
Total		7,154,881.00

Table of unit prices used in former estimates.

	Childs.		Lull, 1874. *a*	Menocal, 1885. *b*	Canal Co., 1890.	Canal Co., 1895.	Board, 1895.
	Nicaragua, 1852.	New York, 1852.					
Greytown Harbor:							
Stone in breakwater	$5.00 6.00	$3.00	$5.00	$1.50	$1.50	$1.50	*c* $1.50
Dredging and excavation	.80 1.00	.20 .30	.30	.25	.20	.15	.25
Canal:							
Dredging				.20	.20	.15	.25
Earth excavation	.25 .30 to 1.00	.15 to .25	.35	.40	.40	.40	.60
Earth embankment	.25	.12	10				
Rock excavation	1.50	.70	1.50 1.25				
Locks and dams:							
Rock excavation	1.50	.70	1.50 1.25	2.00 *d* 5.00			
Earth excavation	1.00 .45 .35 .25	.50 .20 .16 .12	.25 .35 .40	.40	.40	.40	.60
Gravel excavation			1.00 2.00				
Mud excavation	.25	.10				1.00	1.00
Earth embankment	.25 .30	.12			.30	.30	.30
Stone, gravel, and clay embankment	1.00	.50	1.00				
Hydraulic concrete	8.00 7.00	4.50 4.00	12.00 8.00	6.00	6.00	6.00	9.50
Dressed stone	12.00 15.00 16.50	6.75	18.00				
Rubble masonry	6.00 7.00	4.00	9.00				
Dry-stone wall			4.00				
Puddle	.20	.10	.75	.75			
Rock fill					.40		
Divide:							
Rock excavation				1.50	1.50	1.25	1.75
Earth excavation				.40	.40	.40	.60
Fender wales per foot					4.00		
San Francisco Basin:							
Rock excavation				1.50 *e* 5.00	1.50	1.50	1.75
Earth excavation				.40	.40	.40	.60
Earth embankment				*f* .50	.30	.30	.45
Rock fill					.40		
Surface-soil excavation				.30	.50	.40	
Mud excavation						1.00	1.50
Concrete						6.00	9.50
Ochoa Dam:							
Rock fill				(*g*)	.50	.50	.70
Earth, etc., fill				.50	.25	.25	.50
Stone and gravel fill				2.00 .50			
Earth, etc., excavation				2.00 .30	.40	1.00	
Concrete				8.00 9.00	*h* 10.00	*h* 10.00	10.00
San Carlos:							
Earth excavation			*i* .35		.50	.50	.50
Earth embankment					.70	.40	.70
Concrete						6.00	10.00
San Juan River:							
Rock under water	5.00 2.50	2.00 1.00	5.00	5.00	5.00	3.00	5.00
Earth under water	.60	.20		.40			
Gravel, sand, etc., under water	1.00	.50	.40		.30	.25	.30
Earth excavation above water				.40	.40	.40	.50

a The 1874 prices assume cost not greater than in the United States. (See p. 81 of Lull's Report.)
b The 1885 prices assume greater cost than in the United States. (See p. 39 of Report.)
c In 1874 stone for breakwater was to come from Monkey Point; in 1885 from Divide.
d Tunnel. No dams in east division in 1885.
e Tunnel.
f Clay embankment in 1885 to be rammed in 9-inch layers.
g The Ochoa Dam in 1885 to be of concrete, with earth, stone, gravel, etc., backing.
h Concrete in 1890–1895 for abutments.
i For diversion.

Table of unit prices used in former estimates—Continued.

	Childs.		Lull, 1874. *a*	Menocal, 1885. *b*	Canal Co., 1890.	Canal Co., 1895.	Board, 1895.
	Nicaragua, 1852.	New York, 1852.					
Lake:							
Rock under water			$5.00	(*c*)	$5.00	$3.00	$5.00
Gravel dredging	$1.00	$0.35	2.00				
Mud, etc., dredging	.50	.20	.20	$0.40	.20	.20	.30
Stone filling in cribs	2.00	1.00					
Lake to Brito:							
Rock excavation	1.00 1.50 2.50	.70 .75 1.25	1.50 1.25	1.50	1.25	1.00	1.25
Earth excavation	.25 to .60	.13 to .25	.35	.40	.40	.35	.40
Earth embankment			.10				
Diversion of Lajas, etc.:							
Rock excavation	1.50	.95	1.50	1.50	1.25	1.25	1.25
Earth excavation	.25	.12	.30 .40	.40	.40	.40	.40
La Flor Dam:							
Surface soil excavation					.40	.40	
Earth and gravel fill					.20	.20	
Rock fill					.20	.50	
Concrete						6.00	
Locks:							
Rock excavation			1.50 1.25	2.00	1.25	*d* 1.25 1.00	1.25
Earth embankment	.30	.12					
Earth excavation	.25	.15	.40	.40	.40	.40	.40
Concrete	8.00	4.00	7.00 8.00	6.00	6.00	6.00	9.00
Rubble masonry	7.50	4.00			*e* 10.00	*e* 10.00	
Brito Harbor:							
Dredging	1.50	.40	.35	.20	.20	.20	.25
Earth excavation	1.00	.30	.35	.20	.20	.20	.25
Stone	3.00	1.25	4.00	1.50	1.50	1.50	1.50
Minimum depth of navigation ....feet..	17	17	26	26	28	28	30

a The 1874 prices assume cost not greater than in the United States. (See p. 81 of Lull's Report.)
b The 1885 prices assume greater cost than in the United States. (See p. 39 of Report.)
c No rock in 1885. All dredging is at 40 cents.
d Lock 6.
e Above lock 4.

NOTE.—Columns 2 and 3 represent Child's prices in Nicaragua and New York, respectively.

Colonel LUDLOW. That seems to finish for the moment the notes we had prepared on that dredging subject, so you see it is of interest. We did this simply to indicate the assiduity with which we endeavored to get authentic data to guide our judgment to estimate for work upon totally unknown conditions, as far as we knew how. Now for Colonel Rives's estimate. I would like to read that. We had some valuable data from Colonel Rives, a gentleman of whom probably some members of the committee have heard. We are in receipt of specific and detail information from him in the form of a letter written by himself, and being in doubt as to whether he really wished to be quoted in this matter, we telegraphed Colonel Rives, and have this morning the following reply:

CHARLOTTESVILLE, VA., *March 4, 1896.*

The information I gave you in reference to cost of engineering work on Isthmus of Panama is based on eight years' experience and observation. If you deem it of value I have no objection to your making use of it as requested by you. My telegraphic and post-office address is Cobham, Albemarle County, Va.

A. L. RIVES.

A. NOBLE, *Washington, D. C.*

Colonel LUDLOW. This is an interesting letter. The first part gives the rainfall for certain years taken from the canal records at Colon on the Atlantic shore, and at Gamboa, two-thirds of the way across the Isthmus, and at Naos, an island in Panama Bay, for the years 1883, 1884, 1885, 1886, and 1887. Then it gives the Panama Railroad observations in Colon for five years from 1890 to 1894. I have summed it up

in a general way by stating the record shows the rainfall of Panama is about one-half of what it is in Nicaragua.

Mr. STEWART. One-half greater at Panama?

Colonel LUDLOW. Actually about one-half of what it is at Nicaragua. Instead of 25 feet it is about 12½ feet; something like that. Here is the maximum rainfall, reported here at Colon of 155 inches, while at Greytown it is 296.

The CHAIRMAN. I would like to hear the whole of that letter read.

Colonel LUDLOW. We stopped at Colon, and we found Colonel Rives a very charming and hospitable gentleman, and plumb full of information, and undoubtedly the most honest man in the whole of Central America.

[Letter.]

Personal.] COLON, *August 25, 1895.*

MY DEAR MR. NOBLE: I have been so much occupied of late, by reason of the recent labor strike upon our road and its consequences, that I have been unable to reply sooner to the various queries made by you on the occasion of your visit to the Isthmus.

The rainfall statistics of the Isthmus for certain years, from canal records, are as follows:

Year.	Colon (Atlantic shore).	Gamboa (two-thirds across Isthmus).	Naos (island in Panama Bay).
	Inches.	*Inches.*	*Inches.*
1883	115	73	37
1884	105	94	42
1885	146	97	43
1886	137	103	71
1887	155	121	53

The Panama Railroad's observations in Colon for five years, 1890–1894, show a rainfall of 153 inches in 1890, 125 inches in 1891, 145 inches in 1892, 131 inches in 1893, and 154 inches in 1894.

Eighteen hundred and eighty-three and 1884 seem to have been exceptionally dry years. So far this year has been exceptionally wet in Colon and dry in Panama.

In regard to labor, the following statistics throw light upon the subject:

Freight handlers in Jamaica receive 80 cents gold per day; in Trinidad and St. Thomas the same; in Barbados slightly less, but labor there is scarce. Fortune Islands rather more; Curacoa also. In Colombia there are laborers receiving decidedly less, owing to inferior silver and paper currency. Mr. Gabriel Obarrio, an intelligent and well-posted Colombian, is of the opinion that the canal company here can get some Colombian labor at $1.20 silver per day—52 cents gold—but thinks it will require $1.50 silver—65 cents gold—to secure a large supply. It is, however, a labor unused to earthwork.

In the Tropics it would seem scarcely safe to estimate the average output of one of these laborers at more than about half of what might be safely counted on in the United States. During the flush times of the canal company $1.75 silver per day was paid common labor, but the rate of exchange at the time made the daily wages equivalent to $1.20 gold.

The foregoing data and your knowledge of the situation in Nicaragua will enable you to arrive at conclusions. Whatever they may be, however, they are likely to be under rather than over, as the larger the number of workmen needed the more difficult it becomes to maintain low wages.

In regard to the figures for different kinds of work in my "avant projet" for the Panama Canal, they were arrived at by taking contractors' experiences in different sections, with attendant special difficulties, and reducing the figures by obvious possible economies—they were only roughly arrived at.

The masonry contemplated was analogous to that described in the Quaker Dam project for the Croton waterworks, and the figures adopted were based partly upon experience on culverts on the Isthmus and partly upon the fact that such work in the Tropics, even if well conducted, generally costs double as much as in the United States.

Continuous heat, excessive rains, consequent sickness, and inferior labor constitute great difficulties in carrying on important works rapidly and successfully in the Tropics, and render close estimates, as a rule, very deceptive.

Please consider this imperfect reply to your queries as unofficial.

Very truly, yours, A. L. RIVES.

ALFRED NOBLE, Esq., C. E.,
1364 Monadnock Block, Chicago, Ill.

Colonel LUDLOW. Where he refers to his "avant projet," that refers in fact to the present project which the French engineers at Panama are investigating and working over, and which Colonel Rives himself was the first person to put in an engineering form. The idea had been suggested—the engineers and the Panama company were all adrift with the failure of their sea-level canal at Panama—and Colonel Rives being there and professionally interested in those things, took the trouble to collate the data for the first time, made a sketch and drawing, showing the summit-level proposition, and it is now the absolute basis of the company's present project, although he has no connection with the company except as the manager of the Panama Railroad. We telegraphed Colonel Rives and he gave us authority to use this information, if it is considered to be of any value. We are very glad to have it, because it is of great value we think.

Now, in continuation of this same subject; we have extracts here from a published volume in French by the Panama Canal Company of the prices which they indicate as the basis of their estimate of work down there, and they surely have had some prolonged and painful experiences in undertaking work at Panama. These are figures which Colonel Rives, in one case, and Mr. Napoleon Bonapart Wyse, of the Panama Canal Company, in the other, gather independently, and we have simply collated them and put them in parallel columns. You will understand we are talking about canal construction, which is analogous in some respects to the Nicaragua construction. The original proposition was a sea-level canal, over which the French nation nearly broke themselves by trying to do it with the very insufficient information which they had.

Mr. PATTERSON. That was a sea-level proposition?

Colonel LUDLOW. Yes, sir; and the cause of their failure, and in fact the cause of their undertaking an impracticable proposition was because the prior investigation was absolutely defective. That to my mind was the cause of the failure of the Panama project. They had a totally insufficient amount of practical engineering information with regard to the tremendous project which they started to execute.

Mr. PATTERSON. Right there, do you think the Panama Canal practicable?

Colonel LUDLOW. Indeed, I do not know, sir. I would be very glad if I could answer that question in my mind. We were down there, and the show those people made was very surprising. We went there expecting to find a wreck, with the plant lying along the canal route, covered with mud and growth, and with the canal washed full of mud and sand, and everything in ruin.

We found a beautiful prospect, with 10 or 15 miles of canal which we sounded out ourselves, and that told us that even in the several years the work had been abandoned it only filled up a meter and a half, 4 or 5 feet. There was a long stretch of that. We found the line of the canal covered with plant, painted and kept in repair. We found great dredges with watchmen on board and painted and white leaded, and men painting the interior, and we found railroad trains, and con-

struction trains, and railroad plant in an immense quantity, and we found 1,200 or 1,500 men at work at the Culebra Pass with construction plant, and it looked like a very prosperous enterprise. I do not know what are the French engineers' recent data, but since the tremendous failure they have been working hard to get information which they should have had in the first place, and now they are represented as feeling very confident of getting through. What the source of the confidence is I do not know, because we did not examine their data.

Mr. PATTERSON. Do they propose to have locks in this canal?

Colonel LUDLOW. It is a summit-level canal. They enter for 15 or more miles on sea level, and then come three locks, bringing them up to the summit level.

Mr. DOOLITTLE. What is the height of the water?

Colonel LUDLOW. About 100 feet. They come up by these three locks 100 feet, and then they go across this dangerous Culebra Mountain at a high level, and then lock down to the other side to the sea-level section into the Bay of Panama.

Mr. STEWART. Does that beautiful and poetic situation at Panama—do you think they started out without any design or objective point, without having an intelligent engineering design and prospect of what they were going to arrive at? Do you think they arrived at this beautiful and poetic situation which you describe at Panama without any design?

Colonel LUDLOW. Do you mean that I think they started in on the execution of the work without sufficient preparation? Undoubtedly; it is notorious.

Mr. STEWART. De Lesseps does not say so?

Colonel LUDLOW. He is no engineer, if you please. He is an extraordinarily able man, and a very marvelous man, but he is no more an engineer than I am a harpist.

Mr. STEWART. Would he have collected and associated with him men of engineering skill and control led them if——

Colonel LUDLOW. He had the most extraordinary faculty of persuading and dominating other people's judgment of anybody almost in the world.

Mr. PATTERSON. In other words, he was the greatest diplomatist and lobbyist of his age?

Mr. STEWART. You do not say that engineers of renown and ability can be controlled by a man like De Lesseps?

Colonel LUDLOW. I say Mr. De Lesseps was a man of most extraordinary faculty for dominating a man's judgment.

Mr. STEWART. You do not think American engineers could be dominated in that way?

Colonel LUDLOW. I do not think so, not if you give them half a chance. Americans do not enthuse as the Frenchmen do. You get a Frenchman enthusiastic and you can convince him of almost anything.

Mr. STEWART. But an American long abroad and especially in France may participate in that enthusiasm?

Colonel LUDLOW. These things are racial; we are Anglo-Saxon and they are not. They are all right, but they made a beautiful mess at Panama. Enthusiasm does not take the place of hard work and preparation.

Mr. DOOLITTLE. Was this gentleman, whose letter you have just read, down at Panama under De Lesseps?

Colonel LUDLOW. He is manager of the Panama Railway Company.

Mr. DOOLITTLE. Has he not to do with the Panama Canal?

Colonel LUDLOW. He has nothing to do with the canal company.

Mr. PATTERSON. He was before this committee in regard to another matter before you entered Congress. I know him very well.

Colonel LUDLOW. He has been down there some number of years.

Mr. PATTERSON. General Newton, of New York, was president of the Panama Railroad Company and Colonel Rives was general manager.

Mr. DOOLITTLE. Do you say he has nothing to do with the Panama Canal Company?

Mr. PATTERSON. No; he has no connection with it.

Colonel LUDLOW. That is perfectly true.

Mr. DOOLITTLE. I had supposed he had.

Colonel LUDLOW. Being down there, he had naturally the interest of an engineer in the matter, and he spoke French very well, but had no business connections with this canal. His business was railroading.

Panama Canal.—Unit price per cubic yard in United States currency.

	Rives.	Wyse.
Atlantic level:		
Soft dredging	$0.60	$0.37½
Excavation between Locks 1 and 3	1.20	.60
Harbor, Colon	.60	.60
Dredging and enlarging existing canal	.60	$0.45 to 1.20
Summit level:		
Excavation (earth and rock)	1.20	.90
Earth excavation (to the west of slope Culebra)	.....	.45
Rock-fill dam	3.00	.....
Pacific level:		
Dredging in hard material	.....	.60 to 1.35
Dredging large amount	.75	.45
Dredging interior harbor	.75	.37½
Excavation, Locks 4 to 6	1.35	.....
Diversion of Chagres River:		
Dredging in homogeneous material	1.50	.60
Locks:		
Tidal locks, excavation	1.20 to 1.35	1.88
Other locks, excavation	1.20 to 1.35	1.50

Total excavation, 56,000 cubic meters, at an average price of 75 cents (by Wyse)		$42,000,000
Rives's estimate:		
For six double locks		20,000,000
Rock fill		3
Railroad diversion	per mile..	375,000

Mr. STEWART. In view of this immense discrepancy in figures in the Atlantic level, do you consider these figures of Colonel Wyse and Mr. Rives of any value?

Colonel LUDLOW. You notice it is in one special locality. There is Colon Harbor, for example, where Colonel Rives estimates 60 cents, and so does Mr. Wyse, and the discrepancy disappears. These figures we found extraordinarily interesting and valuable to us in our consideration of this subject, as they would be to anyone who had the same matter to consider.

Now, I have a lot of data for the committee if they desire a further continuation of these notes. I have got through with this dredging. We took up the subject of earth excavation above water.

Mr. CORLISS. I suggest that if you do not want to personally examine him on every one of those items they had better be submitted.

The CHAIRMAN. Without they would be useful in the way of answering further interrogatories?

Colonel LUDLOW. I beg your pardon?

The CHAIRMAN. Perhaps the Colonel wants to go on with this question.

Colonel LUDLOW. We are endeavoring to clear up the basis of the estimates.

Mr. STEWART. If the Colonel does not care to read further I should say he ought to have the privilege of printing with the stenographer's notes anything further he desires.

Colonel LUDLOW. This is for the information of the committee.

Mr. CORLISS. I think it ought to be printed.

Mr. PATTERSON. As far as I am concerned it is an important subject, and I want to hear the Colonel discuss this subject, and along with it submit the data.

The CHAIRMAN. I would like to ask, with reference to the figures you have used there, are we to understand those are prices paid, or simply estimates of Colonel Rives and Mr. Wyse?

Colonel LUDLOW. They are estimates based upon a prolonged experience on the Isthmus, and constitute the basis of their judgment of what this work will cost under physical conditions, which in several important respects are favorably comparable with those which exist at Nicaragua.

The CHAIRMAN. Do you understand they were based upon prices which have been paid?

Colonel LUDLOW. Yes; because Colonel Rives, in his letter, refers to prices which have been paid in times past, and that is used as the basis of the judgment. He does not use the extravagant prices paid during the orgie of the Panama Canal.

The CHAIRMAN. In referring more particularly to these estimates of Rives and Wyse, were they based upon prices paid by the company, or were they simply their estimates, without any knowledge of what the actual cost would be?

Colonel LUDLOW. They were based upon the fullest knowledge of what work of that kind had cost under different conditions in years past in connection with work down there done for both the canal and railroad, when he had close and accurate knowledge of what he had to pay for that work and what the labor was worth after he bought it.

Mr. DOOLITTLE. This question you have somewhat covered, but nevertheless I will ask it. Actually, what minimum responsible price do you now think you could let this dredging for? If you could not let it for less than 25 cents, why could not the company hire competent men to build and operate the proper plant for 10 cents per cubic yard?

Colonel LUDLOW. That is a matter of business detail, and it does not seem to me to have anything to do with the estimated cost. We have expressed our judgment as to what that work will cost, and we have estimates of other people whom we regard as authorities, and who are inclined to put a price higher on it than we did.

Mr. DOOLITTLE. Now, if we found responsible contractors who would be willing to take that dredging down at Greytown and a similar character of dredging along the line of the canal for 10 cents a yard, of course that would be a material saving?

Colonel LUDLOW. Of course.

Mr. DOOLITTLE. A very large saving in the total?

Colonel LUDLOW. Providing he did it at that price.

Mr. DOOLITTLE. Provided, of course, that the work could be carried on at that figure?

Colonel LUDLOW. You would undoubtedly save half the estimated cost if you get it done at that price.

Mr. DOOLITTLE. Now, your estimate adds 20 per cent to the dredging item. Simple sand, clay, etc., are known to exist. Why do you consider a contingency may transpire which would require this 20 per cent allowance? If you have the field of material before you, and if you know the length of time which is going to be required to remove it, the cost of creating the plant and all the engineering, why should 20 per cent be added?

Colonel LUDLOW. I think I can answer that in a word. Experience has shown you have got to do it. With all the organized careful estimating that the English engineers were able to do on the total amount of work to be handled on their Manchester Canal, the actual amount taken out was 19 per cent greater than the amount they estimated.

Mr. DOOLITTLE. Nearly one-fifth greater?

Colonel LUDLOW. Yes, sir; 1 per cent more would have been exactly one-fifth.

Mr. PATTERSON. In other words, you follow the rule adopted by engineers of adding 20 per cent to the estimated cost?

Colonel LUDLOW. It depends upon the nature of the work. Some work you can estimate to within 5 or 10 per cent, but all these works of great magnitude, involving the handling of materials, and particularly when they have the complications due to water, it is not safe to use less than 20 to 25 per cent contingency.

Mr. STEWART. In view of the miscalculations made by the engineers on the Manchester Canal that could be avoided in estimating on the Nicaragua Canal, their experience would enrich the calculators on the Nicaragua Canal?

Colonel LUDLOW. It enriches the wisdom of the earth and guides the judgment of engineers, and when he has a formidable problem to solve ahead of him, the conditions of which it is impossible to ascertain, he puts on 19 or 20 per cent.

Mr. STEWART. You say they made a 19 per cent mistake at Manchester?

Mr. PATTERSON. I do not understand Colonel Ludlow to say they made a mistake.

Colonel LUDLOW. I stated that the best estimate they could make for the total amount was less by 19 per cent.

Mr. STEWART. Well, they were 19 per cent out of the way. Why could not the engineers of the Nicaragua Canal be 19 per cent in the way?

Colonel LUDLOW. We do; we add 19 per cent on, and so with every other enterprise.

Mr. DOOLITTLE. When the ground is known, the price of plant, operation, fuel, etc., can be carefully figured in the light of modern analysis and methods, why do you need to add 20 per cent to such plain items? Is not your estimate for dredging, therefore, unnecessarily excessive?

Colonel LUDLOW. That is simply the whole ground all over again. How are you going to answer that question? How would you answer it?

Mr. DOOLITTLE. I am not answering it; I am not an engineer.

Colonel LUDLOW. Will you read that again, slow like?

Mr. DOOLITTLE. When the ground is known, the price of plant, operation, fuel, etc., can be carefully figured in the light of modern analysis and methods, why do you need to add 20 per cent to such plain items?

Colonel LUDLOW. The premises are extraordinary; nothing of the kind is known.

Mr. DOOLITTLE. And can not be to a skillful engineer?

Colonel LUDLOW. Whether he is skillful or unskillful he does not know it. The more skillful he is the more he would not know about it. The more ignorant, the more confident he would be. Wisdom or skill does not necessarily make a man less cautious or prudent.

Mr. DOOLITTLE. Mr. Sherman suggests, Why not place it at 24 cents instead of 25 cents?

Colonel LUDLOW. Because we thought 20 cents would do it.

Mr. SHERMAN. You did not because you added on 20 per cent?

Colonel LUDLOW. We did not want to increase this unit price above what we believed would be a very conservative and safe figure. As I have shown you, the contractors we consulted, and other gentlemen who know, gave figures if anything larger than ours, and I do not understand—Mr. Noble very properly calls my attention to the fact that this contingency is a general item applying to the whole work. There may be some portions of the work on which the contingency is excessive. There are unquestionably other portions of the work on which that contingency is very small, and in reference to that portion of the work would be extravagantly understated, where the contingency might run to 50 or 100 per cent.

Mr. DOOLITTLE. Then the 20 per cent is rather in the way of an average?

Colonel LUDLOW. What else? We do not profess to know what the Ochoa Dam is going to cost.

Mr. DOOLITTLE. So you threw in this 20 per cent to cover all inequalities?

Colonel LUDLOW. Yes.

Mr. PATTERSON. Is it not true that Mr. Menocal in his estimate threw in 20 per cent?

Colonel LUDLOW. Perfectly true; sometimes 20 and sometimes 25.

Mr. PATTERSON. I understand that is universal among engineers?

Colonel LUDLOW. In work of this kind.

Mr. PATTERSON. And the difficulty in answering a question about it is if they knew all these things and knew how to answer all these things, knew how to analyze and get the ultimate analysis of every item of cost, there would be no necessity of the 20 per cent, but it is simply impossible, and so they add in the 20 per cent?

Mr. DOOLITTLE. So as to round up and make a good average?

Colonel LUDLOW. We have two typical works of this character. We have the Suez and the Manchester canals. Take the Manchester Canal. The Manchester Canal is provided for under Parliamentary authorization on the basis of £6,000,000 for the engineer's construction estimate. I am speaking in round numbers. Six million pounds is $30,000,000 for 35½ miles of canal. The incidental expenses of construction, overhead bridges, rights of way, and compensation to private holdings, covering for centuries that land through which that canal went, increased the estimated cost of the project from £6,000,000, which was the engineer's estimate loosely stated, to £10,000,000 for which Parliament granted the authorization they procured. Now, the actual cube of excavation when they came to build it resulted in 19 per cent greater than the estimated cube, among other things because the river floods came in and washed a whole lot of stuff in there after they had painfully excavated it, and they had to do it over again. Disasters of that kind no man can anticipate.

The actual expenditures made on that canal are now rising—£15,000,000, or $75,000,000. Those are the actual outlays on an original

basis of $30,000,000, construction estimate, and the $50,000,000 basis, including outside expenses as well. There is an illustration of the Manchester Canal, executed in the heart of England and with the best engineering they knew how to get for it. What is the history of the Suez Canal, estimated at $40,000,000? A canal which within ten years had cost $110,000,000 after they had very largely reduced the cross sections and dimensions of it.

Mr. DOOLITTLE. There were very many elements included in the Suez Canal.

Colonel LUDLOW. There is the element of contingencies to be added on, which reached ultimately $110,000,000—250 per cent, instead of 20.

Mr. DOOLITTLE. Now, I want to ask about the rock to be used in the construction of the jetty work. If the rock used for the purpose of constructing the jetty at the mouth of the Columbia River could be quarried and transported 110 miles and put in place on the jetty for $1 per cubic yard, how do you justify the price of $1.50 per cubic yard for simply transporting the rock material for the jetty 15 miles. I should like to know how that happened?

Colonel LUDLOW. We have to open at the outset a special quarry, because you have to get to the eastern divide before you can begin to quarry it, and you have to get your harbor at the very outset long before you tackle that east divide. There would be two or three things before you can get rock out of the east divide.

Mr. DOOLITTLE. The rock would be taken out of the divide?

Colonel LUDLOW. No.

Mr. DOOLITTLE. To build the jetty rock work?

Colonel LUDLOW. No.

Mr. DOOLITTLE. Where would you take it from?

Colonel LUDLOW. From a place near Lock No. 1, where there is a favorable place for a small quarry.

Mr. DOOLITTLE. That would be in the way of the excavation upon the canal?

Colonel LUDLOW. No; that is practically dead work, and the company's figures now are about the same, exactly the same to the cent, I believe. There is no difference of opinion there.

Mr. DOOLITTLE. Is it not contemplated in the company's plan that rock shall be taken out of the canal for the purpose of constructing these jetties?

Colonel LUDLOW. There is no rock in the canal——

Mr. DOOLITTLE. I mean in the cut.

Colonel LUDLOW. There is in the east divide ultimately, but you can not do that at the outset, and the painful necessity at the outset is that you must have a harbor. There is the great criticism and objection, if you choose, to that Nicaragua route, that there is no harbor there, you can not land anything.

Mr. DOOLITTLE. How would these conditions apply to the portions of the rock to be taken out of the rock cut?

Colonel LUDLOW. I think the company's price is about the same there. I think the canal company's price of 1895 is $1.50 and our price is $1.50. It has been $1.50 right along. We are very glad to have our figures the same.

Mr. DOOLITTLE. In view of this question where the rock was transported a distance of 110 miles to the mouth of the Columbia River——

Colonel LUDLOW. It is impossible to transfer the whole conditions existing on the Pacific Coast in Washington down to the conditions existing on the Caribbean coast at Nicaragua and compare that magnificent climate and these illimitable resources up in that country.

Mr. DOOLITTLE. The resources in rock are a good deal nearer than 110 miles from the jetty?

Colonel LUDLOW. And there you have a lot of dagos and Jamaica negroes, and the climate you have to look out for. The whole thing is different. How much rainfall do you have in Washington?

Mr. DOOLITTLE. One hundred and ten or 120 inches.

Colonel LUDLOW. And at Greytown they have 25 feet of water.

Mr. DOOLITTLE. Annual rainfall?

Colonel LUDLOW. I mean in a year 25 feet of downfall of water. What is the height of that ceiling? About 18 feet, I should say. There is a body of water 50 per cent higher than this arch which you have to take account of in a year, and it rains every day. Down there, they say, it rains every day, and every other day it pours.

Mr. DOOLITTLE. Now, a portion of the expense of taking this rock out is, of course, figured in in the estimate where it is taken out of the rock cut?

Colonel LUDLOW. I will just state one item, since this matter is broached. Two inches of rainfall in the United States will drive a man off work, and down there you get three inches in an hour.

Mr. DOOLITTLE. But still they continue to work right along?

Colonel LUDLOW. Yes; some of the men do; but how much work do you get out of them? That is one of the circumstances which depreciates the value of labor in that country.

Mr. DOOLITTLE. Now, if a portion of the work be used in the construction of these jetties, is it not estimated for in the cutting of rock—that is, the quarrying?

Colonel LUDLOW. That is the $1.50 charge? We have considered that that is an additional charge.

Mr. DOOLITTLE. Apparently.

Colonel LUDLOW. We agreed with the company.

Mr. DOOLITTLE. But should it be actually?

Colonel LUDLOW. We and the company agreed it should be.

Mr. DOOLITTLE. I do not care about the company's agreement in this connection.

Colonel LUDLOW. Yes; we say it ought to be done, or we would not have done it.

Mr. DOOLITTLE. But you do not want to make a double charge for the same work?

Colonel LUDLOW. Why not?

Mr. DOOLITTLE. Why should you, if the material is cut at the rock cut—why should you charge for quarrying, so far as you use it——

Colonel LUDLOW. We do not charge for quarrying.

Mr. DOOLITTLE (continuing). So far as used in the jetties is concerned?

Colonel LUDLOW. We charge for taking it from that point.

Mr. DOOLITTLE. Then it is simply a matter of transportation and dumping?

Colonel LUDLOW. There is a certain amount of handling.

The CHAIRMAN. I understood you to say the rock is to be used on the jetty before you reach the divide?

Colonel LUDLOW. A portion. I am perfectly willing to meet every question. These engineering matters are extremely interesting, and also improving.

Mr. DOOLITTLE. I shall be very glad to be improved in this direction.

Colonel LUDLOW. I do not mean that, but they are pleasant subjects of discussion.

Mr. DOOLITTLE. They are vastly interesting to me.

Colonel LUDLOW. Yes, sir; and occasionally useful. If a piece of rock from the divide cut after you have quarried it and paid 50 or 75 cents to the man to handle, you take and put on a car and deliver at a jetty 12 or 13 more miles away, you have got to bring it the length of that track and you have got to handle it down there. How are you going to get across the harbor to this jetty where you want to put this piece of rock? You have to build a trestle railroad across the lagoon to get out there. You have to have apparatus on the pier to deliver the stone, you have to follow the construction out with your railroad construction. You have got all this expense.

Mr. DOOLITTLE. Does not this estimate for quarrying rock for use on these jetties apply to rock to be used for this purpose in this estimate? I so understand the estimate.

Colonel LUDLOW. That it is a double charge on the quarrying; not in the least.

Mr. DOOLITTLE. I say you charge for the rock in your estimated cost of the jetty just as though the rock was quarried for use on those jetties, do you not?

Mr. NOBLE. You see that portion of the report where we say a part of the rock will have to be quarried because a part will have to be built before the divide cut is commenced.

Mr. DOOLITTLE. I have not been able to understand the explanation. I will ask you again, if you do not charge for the quarrying of all the rock to be used on the jetties?

Colonel LUDLOW. No, sir.

Mr. DOOLITTLE. What portion do you charge for?

Colonel LUDLOW. The preliminary part we use for the necessary preliminary construction of the jetty before you tackle the east divide at all. We have to open a quarry, and that is dead work.

Mr. DOOLITTLE. Can you readily state there the amount of work you charge for quarrying?

Colonel LUDLOW. I guess so. I think the quantities are stated here—no; I guess that is exactly what we did; we made a mistake there. I admit that. For the preliminary portion we did not separate it, and we ought to have charged an additional price.

Mr. DOOLITTLE. And then for the other, you should not have charged for the quarrying?

Colonel LUDLOW. No; that remains just the same.

Mr. DOOLITTLE. I do not so understand it.

Colonel LUDLOW. I understand it this way, that the $1.50 charged for the rock taken from the divide is not a duplication of the original quarrying charge on that divide. At the outset we have to take rock, not from the divide, but from the quarry, which we have to open and which has nothing to do with the canal construction at all, and we made a mistake in including that with the other rock, which we are supposed to haul from the divide. We have not added for a portion of this rock an extra charge for quarrying.

Mr. DOOLITTLE. I will read this. Remembering that the cost of quarrying and putting on the car is already figured in the divide-cut estimate, why should it cost more than a cent a mile, or $15 a ton, to transmit this material from the rock cut to the jetty? It is merely a question of transportation and dumping when you get a place to dump on the jetty.

Colonel LUDLOW. Put it this way. How much do you pay for your rock on the divide? Rock excavation, $1.50, recently reduced to $1.25, and we put it at $1.75. What is the matter with charging $1.50 for putting on the jetty?

Mr. DOOLITTLE. The question is, the actual expense of putting it on the jetty would be simply a matter of transportation, having your transportation line.

Colonel LUDLOW. And handling of course, and a portion of the work is we have to open up a quarry, which is dead work.

Thereupon the committee adjourned to meet at 10 a. m. Tuesday, May 5, 1896.

MAY 5, 1896.

The committee met at 10.15 a. m., Hon. William P. Hepburn in the chair.

STATEMENT OF COL. WILLIAM LUDLOW—Continued.

Mr. DOOLITTLE. Colonel Ludlow, after leaving Greytown how many days were the Board on the line of the canal?

Colonel LUDLOW. We were in and about the line of the canal from the time we arrived at Greytown until we left Nicaragua. I say that we were in and about on the line of the canal all the time, except when we made a trip to Managua.

Mr. DOOLITTLE. How many days were consumed by the Board along the line of the canal after leaving Greytown?

Colonel LUDLOW. What do you mean by the "line of the canal?"

Mr. DOOLITTLE. You have stated in your examination that you passed over the entire line of the canal.

Colonel LUDLOW. Yes.

Mr. DOOLITTLE. I ask you how many days were consumed after leaving Greytown?

Colonel LUDLOW. The minutes of the Board show where we were every day. I would refer to the official records.

Mr. DOOLITTLE. Are not you able to state how many days?

Colonel LUDLOW. No; nor how many hours.

Mr. DOOLITTLE. I just asked you about the days.

Colonel LUDLOW. From the time we arrived at Nicaragua until we left there was not a day, or part of a day, that we were not on or about the line of the canal, except when we went to Managua, and then we took in Lake Nicaragua.

Mr. DOOLITTLE. Are not you able to state, from any data you have or from memory, how many days you spent along the line of this canal after your party left Greytown?

Colonel LUDLOW. With the exception of the trip we made to Managua, we were on and about the line of the canal forty days. That is what we were there for.

Mr. DOOLITTLE. How many days were you traveling over the route of the canal after leaving Greytown?

Colonel LUDLOW. I will get the minutes and read right off the record to you. That is important?

Mr. DOOLITTLE. Yes, sir; it is to me.

Colonel LUDLOW. We spent five weeks there, on and about the line of the canal and Lake Nicaragua all the time, in the investigation of the business we were down there to investigate. As to the actual number of days we spent on the line of the canal—that is what I suppose you are trying to get at—I would ask if you consider the river a part of the canal?

Mr. DOOLITTLE. Yes, sir; throughout that portion of it that is to be a part of the canal.

Colonel LUDLOW. Do you consider the lake a part of the canal?

Mr. DOOLITTLE. Do not you?

Colonel LUDLOW. Part of the project, not of the canal. No; there is no canal work in the lake any more than at the construction of the Greytown Harbor.

Mr. DOOLITTLE. I ask you a simple question: How many days were you on the canal?

Colonel LUDLOW. I will try to tell you by the record. I will read the minutes to you just as they were made up. There is only one way to tell the facts, and that is to tell them.

Mr. PATTERSON. Have the minutes read through from beginning to end.

Colonel LUDLOW. If you want me, from memory, to say how much time was spent on the exact line of the canal, I will ask you, in the first place, to tell me what you mean by the line of the canal?

Mr. DOOLITTLE. As an engineer, I supposed you would be better able to state what the line of the canal was than I, who am not an engineer, and have never visited the canal.

Mr. PATTERSON. You used the term "line of the canal." While he has a definite belief as to what the line of the canal would be, he simply differs from you as to what is embraced in that question.

Mr. DOOLITTLE. Then along the company's projected line of the canal.

Colonel LUDLOW. Of the canal only?

Mr. DOOLITTLE. Of the canal.

Colonel LUDLOW. Do you include——

Mr. DOOLITTLE. I include the whole passage from Greytown to Brito.

Colonel LUDLOW. Do you include in that the crest line of the embankments in the San Francisco basin?

Mr. DOOLITTLE. I certainly do, for those are a portion of the company's proposed route for the Nicaragua Canal.

Colonel LUDLOW. You are quite right, sir.

Mr. DOOLITTLE. Thank you.

Colonel LUDLOW. Then we are clear about that. That was our own interpretation of it. You will understand for a portion of the route, between the east divide and the Ochoa Dam and River, there are two lines. One is the axis line of the canal and the other is the line of low hills where the San Francisco embankments are to be built—for the construction of these great basins.

Mr. DOOLITTLE. Perhaps I can simplify the matter.

Colonel LUDLOW. I understand.

Mr. DOOLITTLE. You did not at first and have not since. How long from the time you arrived at Greytown were you getting over to the Pacific—how long before you reached Brito, taking out the days you stopped for transportation?

Colonel LUDLOW. I will follow that up.

Mr. DOOLITTLE. Can't you give the number of days without doing that?

Mr. PATTERSON. I would suggest——

Mr. DOOLITTLE. I am asking the question, and would like to get the answer to the question.

Colonel LUDLOW. Remember, this was last summer. We have made up our report on it, and it never occurred to us to figure up the time spent on this and the other portion of the route. We were all the time engaged in this work.

Mr. DOOLITTLE. I am asking you how much time you were passing over the line of the canal?

Colonel LUDLOW. I say it never occurred to us to figure it up. I will figure it up for you, if it is of any value.

Mr DOOLITTLE. If you please.

Colonel LUDLOW. We landed at Greytown first. This seems to be a matter of considerable importance, and it is well to go definitely to the record. I will get it and read the minutes right through. We landed at Greytown on the 13th of May; anchored off Greytown entrance at 12.30 p. m.; landed that afternoon, and went to our quarters that night, after certain formalities with local authorities. On the 14th—the next day—a formal call was made on the governor.

Mr. DOOLITTLE. You can omit that. State when you left Greytown to go to Brito.

Colonel LUDLOW. You do not want the first week, then?

Mr. DOOLITTLE. Not at all. I am asking you about the length of time after you left Greytown.

Colonel LUDLOW. I am perfectly willing to give you the information. This is a sort of clerical work, not engineering. I am willing to do it, however, if it is any advantage to the committee. I will try to get away from Greytown. We spent the first week there investigating the harbor. We left May 21 on the river boat. We went up the river, examining the lower San Juan on the road, to its junction with the Colorado. This is up the main stem of the river—you can follow it up on the map there very well—stopping at 6 p. m. at Orans. At 8.30 tied up for the night to the right bank, below the mouth of the San Carlos. That is the first day's journey.

Mr. DOOLITTLE. Now, can you state when you reached Brito?

Colonel LUDLOW. Certainly. You want to know that? I thought you wanted to know what we did.

Mr. DOOLITTLE. I am not asking you what you did; simply the number of days you spent in traversing that isthmus.

Colonel LUDLOW. Well, we went up the river. We transferred three or four times at the various rapids. We traveled across the lake up to Managua, and back again to Rivas. On the morning after we arrived at Rivas we left early. Thursday, May 30, was spent in examining the Brito harbor and vicinity.

Mr. DOOLITTLE. On May 30?

Colonel LUDLOW. If you will be good enough to make the necessary subtraction it will give you the number of days spent in that portion of the work.

Mr. DOOLITTLE. How many days at Managua, and how many at Rivas?

Colonel LUDLOW. No days at Managua.

Mr. DOOLITTLE. What time was consumed on the line of the projected canal at this place, on your trip?

Colonel LUDLOW. You mean Managua?

Mr. DOOLITTLE. Rivas, you say.

Colonel LUDLOW. Rivas is on the line—the immediate vicinity of the line—and the only stopping place for us. We had no other recourse. We left Fort San Carlos in the lake steamer Victoria with our entire party. Arrived 3.15 on the 26th of May. Now I have got it. On the 26th of May, at 11.30 p. m., we sailed across the lake; started across the lake for San Jorge, which is in the immedate vicinity of the canal route and the only landing there. We arrived at San Jorge 9.20 a. m., Monday, May 27. We landed our party at 9.20 in the morning, and the board, as a board, together with Mr. Menocal, Dr. Stitt, and the secretary of the board, continued the voyage up the lake from San Jorge to

Granada, and arrived at Granada at 3 p. m. A special train, by the courtesy of the Government, took the board to Managua, where we arrived at 8 p. m., taking quarters at the hotel, and went to bed.

This was the 27th. The next morning at 9 a. m. we had a special audience with the President and members of his cabinet, and at 10.15 the special train returned the board to Granada, and at 11.30 a. m. the *Victoria* sailed again for San Jorge, down the lake, arriving at 6.40 p. m. of May 28. The board proceeded by tramway to Rivas and to quarters there which had been prepared for us in advance. While the board, as a board, was proceeding to the capital of the State to pay our respects to its President, the party were preparing, in the getting together of animals, freight carts for transportation, the construction of a camp, and other preparations for the examination of the western division, so that, so far as the time of the board was concerned, we lost nothing while the party was making preparations.

The board arrived at Rivas on the evening of May 28, and on the morning of Wednesday, May 29, we left Rivas after breakfast, and proceeded with the animals, etc., and most of the party, to the hacienda near Brito, which had been kindly loaned to the board by the owner, and where we were quartered for the night. We arrived there at 4.30 p. m. If I remember that is within 2 or 3 miles of Brito Harbor. We got there at 4.30 p. m., after rather a fatiguing journey in the hot sun. The next day, May 30, we occupied the entire day in inspecting Brito Harbor and vicinity, making very important and valuable observations, as we believe, and if the committee will be good enough to read our report, I think that they will agree that we made good use of our time there.

I have answered your question, sir; that is, from Greytown to Brito.

Mr. DOOLITTLE. Now, when did you return to Greytown—on what date?

Colonel LUDLOW. I will tell you that presently. We arrived at Greytown, going back on the evening of June 18, at 5 p. m., to be accurate, and immediately arranged there for the inspection of the Lower Colorado, of the junction, and the entrance.

Mr. DOOLITTLE. Can not you tell from memory or easily from the data before you how many days you were traveling between May 30 and June 18 over the line of the canal?

Colonel LUDLOW. How many days we were traveling?

Mr. DOOLITTLE. Yes, sir.

Colonel LUDLOW. Between what points?

Mr. DOOLITTLE. Between Brito and Greytown.

Colonel LUDLOW. On the return journey?

Mr. DOOLITTLE. Yes, sir; on the return journey.

Colonel LUDLOW. I can tell you that by telling what we did every day. It might be interesting, since our doings there have been so travestied. Why should not the committee know?

Mr. CORLISS. Was not the date of the final arrival at Greytown the answer to that?

Colonel LUDLOW. No; he seeks to know what we were doing in the interval.

Mr. DOOLITTLE. I said, how many days were you making the actual journey between Brito and Greytown?

Colonel LUDLOW. I have given you that.

Mr. PATTERSON. I would like to have the minutes put in the record to give the facts.

The CHAIRMAN. The Colonel will answer the question in his own way.

Colonel LUDLOW. You will observe the minutes are a part of the record already and one of the appendixes of the report of the board.

Mr. PATTERSON. I understand that; but what I mean by the record is your examination.

Colonel LUDLOW. I do not know any way to tell you except to run over it from Brito to Greytown, Mr. Doolittle. We took the entire day of May 30 inspecting the Brito Harbor and vicinity, and returned to our quarters at the hacienda. The next day, May 31, we examined the canal route up the Rio Grande River, giving especial attention to the La Flor Dam, and camped at Paraiso, which is an intervening point, where we had erected a subcamp for our accommodation between the La Flor Dam and the lake on the western division. We camped at Paraiso. The next day we followed the canal line to the lake shore, examined the proposed site for the dam, etc., and at 4 p. m. left the lake shore for Rivas, where we arrived at 7. There were two days occupied on that western division route. On the 2d of June the party was engaged in taking levels and other measurements on the lake shore. We were now endeavoring to arrange for our return across the lake.

Mr. DOOLITTLE. Did you not go over all this matter, and these details, in your former statement to the committee?

Colonel LUDLOW. No.

Mr. DOOLITTLE. That is, about visiting the different points along the line of the canal?

Colonel LUDLOW. Not materially.

Mr. BENNETT. Mr. Endicott did that, Mr. Doolittle.

Colonel LUDLOW. I think Mr. Endicott went over that.

Mr. DOOLITTLE. Of course I do not care to take up the time of the committee in getting all these circumstances, inasmuch as it appears in the record. I thought you might be able to answer simply about the number of days.

Colonel LUDLOW. I understand, of course, by reason of the fact that the statement was made here that we only occupied fourteen days on the line of the canal. There is something in that. You can figure it fourteen days, or figure out ten days. We might not be inspecting the canal when we were inspecting the crest line, if you choose; might not be inspecting the canal when we were inspecting the river. Perhaps you would exclude the time we were examining the lake; perhaps a visit to a quarry, where it was understood stone was to be obtained, should be excluded from the days. There is a good deal of that sort of thing. I suppose that our week at Greytown surveying the harbor and getting all the information we could about this was not on the line of the canal. It is admitted we spent a day at Brito examining the harbor, and that that day we were not on the line of the canal, when we come to construe it in that way. That is why I ask you what interpretation you give to the words "the line of the canal." Do you mean the axis of the canal? In the San Francisco and other basins the axis of the canal crosses deep basins—no excavating to be done. The engineering is on the crest line as much as two and a half miles from the line of the canal.

Mr. DOOLITTLE. It would also be necessary to go there?

Colonel LUDLOW. On the axis of the canal? Along a large part of that is a swamp. We accepted the company's data as to that. We would say it was a swamp.

Mr. DOOLITTLE. Did you pass over the entire line of the canal?

Colonel LUDLOW. The whole axis of the canal proper? Surely not. There are places we could not get over. You can not get over the line from Greytown to the foothills, for example, because it runs through a swamp where no man can go. We took the railroad.

Mr. DOOLITTLE. Above the swamp, did you go over the axis of the canal all the way from the foothills to the lake?

Colonel LUDLOW. There are parts that are inaccessible. We went over the portion which the company had been kind enough to clear away for us; and where there were two lines partly cleared the canal line had been almost wholly cleared, the crest line, which is, of course, the important critical line; there was no need for us to abandon a critical engineering location to go to look at the bottom of a swamp that was to be filled with water 40 feet deep. We were not wasting our time there.

Mr. DOOLITTLE. With reference to the concrete work, you have figured out $9.50 per yard. Now, can you state the price at which cement can be delivered down there?

Colonel LUDLOW. I will tell you all about it, sir, as far as we know, and we got the best and most authentic information we could. We got this information in order to save the time of the committee. We spent our own time in collecting it and getting it in shape, and I shall be very pleased if the information is of any value to the committee. It was of immense value to us. We reached over this country and Europe for information on this subject. I will read the notes we prepared. Of course, this is not complete, but perhaps as much as you will need.

The board's estimate for the cost of concrete is based on the following particulars: The price of cement was furnished by the New York agent of one of the principal German manufacturers. The agent wrote full particulars to Germany and had the reply cabled. The prices were $2.30 per barrel, f. o. b., Greytown, and $2.42, f. o. b., Brito. The board endeavored to make an estimate for unloading, landing, transporting, and storing this material, with an allowance for the inevitable waste in that damp climate. You will understand there are no harbor facilities at either end. The result was that we adopted a unit price of $2.60 at the site of the work on either slope as the probable cost of the cement to be used in that concrete.

Mr. DOOLITTLE. Do you know what the price of portland cement is delivered in Chicago, or did you know at the time you made up this estimate?

Colonel LUDLOW. Yes, we had those prices, and we had the Government price of cement from probably twenty points.

Mr. DOOLITTLE. Did you have a report of prices of cement delivered on the Pacific Coast, around the Horn?

Colonel LUDLOW. Well, I got it direct from Government officers who had imported the cement. We didn't slight it.

Mr. DOOLITTLE. Have you that data right at hand?

Colonel LUDLOW. I suppose we have twenty figures for cement; whether we have it all here, I don't know. What was the price of cement on the Chicago drainage? (Addressing Mr. Noble.)

Mr. NOBLE. They are paying now from $2.25 to $2.85 for a good grade of imported portland cement.

Colonel LUDLOW. The sand for the concrete is to be obtained from the beach in either case, for the eastern division from Greytown and for the western division from Brito. It must be hauled from there; it must be gathered, transported, and delivered where required. The estimated cost at the site of the work is 55 cents per cubic yard on the eastern slope and 50 cents on the western slope. That figure includes collection, transportation, and delivery at the site of the work. That figure is not unreasonable. The cost of sand at St. Marys Falls Canal Lock has been somewhat more than 40 cents per cubic yard, all the con-

ditions being less expensive, the point of collection being nearer and the expense of handling considerably less. The board's estimate is very low, comparatively.

The estimated cost of broken stones delivered at the site of the work is $1 on the Atlantic slope and 90 cents on the Pacific slope. This includes the cost of sorting and loading the stone at the spoil banks, transporting it several miles to the site of the work, unloading, and crushing. The cost for the same item at the St. Marys Falls Canal has been between 80 and 90 cents. You will observe that we make what we believe to be an intelligent and proper discrimination between the cost of the work on the eastern division and the cost of the work on the western division in favor of the western division, a difference of 10 cents, on account of the more favorable climatic and other conditions that exist there.

At St. Marys Falls the stone is obtained within 1,000 feet of the site and, as I said, cost between 80 and 90 cents per cubic yard. We did not believe that if it cost 80 and 90 cents at St. Marys Falls Canal it would cost less than 90 cents at Brito or $1 on the Greytown side. We may have made mistakes in these estimates, but the trouble is they are too low. Basing an estimate for a single cubic yard of concrete on the unit price of these three materials, and using the proportions specified to us by the company as being those which they expected to use, viz, cement 1, sand 2, broken stone 5, we have the following tables of cost of the work:

1. Eastern division:	
1.47 barrels of cement, at $2.60	$3.82
0.36 cubic yards of sand, at 55 cents	.20
0.91 cubic yards of stone, at $1	.91
Timber forms (material and labor)	1.00
Plant	.50
Labor (mixing and placing)	1.50
Total	7.93
Contractor's profit (20 per cent)	1.59
Cost for 1 cubic yard of concrete	9.52
Price adopted by the board	9.50

Mr. DOOLITTLE. You place the labor used in mixing and placing the concrete at $1.50. That would be by machinery, would it not?

Colonel LUDLOW. Surely; it is done by hand, but in large quantities you must use machinery in order to get through, but some work can not be done by machinery. That is on the eastern division. Total, $7.93; contractor's profit, 20 per cent—making $9.52.

Mr. DOOLITTLE. What was the last item? I didn't catch that.

Colonel LUDLOW. Contractor's profit, 20 per cent. Now, if you please, we will look at the same subject in the western division. This is a very interesting subject, and you will observe we have no information from the company. There is not a word beyond the general proportions, not a word showing how that price they used was obtained.

Mr. DOOLITTLE. The cost of cement is not made up for estimates for any such amount of work as this. Is that based on the total amount of cement to be used?

Colonel LUDLOW. Our price for cement was quoted at a wholesale rate.

Mr. NOBLE. A million barrels was put down as the quantity, and estimates made on that basis.

Colonel LUDLOW. The wholesale price is what we were after. We

were not buying two barrels. Now we come to the western division. Without reciting all of the particulars, the estimates of which run close to those for the eastern division, the cost of concrete on the Pacific side, including contractor's profit, adds up to $9.08, the eastern price being $9.52.

The difference in favor of the western division was due to the greater cost of cement being more than offset by the better climatic conditions on the Pacific side. The detailed estimate figures out $9.08. The board adopted for the western division the price of $9, and the committee will observe that in both these cases we actually adopted as the unit price a figure less than the total of the detailed items in the estimate. In one case $9.52 became $9.50, in the other case $9.08 became $9. Now, what supplements this estimate or supports it? As stated in the report of the board, the cost of concrete of the same proportions used in the locks of the Hennepin Canal, between Chicago and the Mississippi River, was $9 per cubic yard. That is in this country. It is not far from Chicago, with every resource for transportation at hand.

This was done by hired labor, and includes no allowance for profit; it was done by the Government. The cost is greater than the usual cost of concrete of these proportions in the United States, and is due to the great care and thoroughness with which the work was done. In connection with such important construction as is in question in this case—the construction of a lock of enormous magnitude almost exclusively of concrete—you can not cheapen your material; it is necessary to have the best you can get. This was on Government work, and it came to $9 a yard. We got this information from first hand. We do not believe that this estimate, although an unusually large one for the United States, can by any possibility be safely reduced for the totally different conditions, much more difficult, under which similar work must be done in Nicaragua.

The cost of concrete of the same proportions under current contracts at the Brooklyn Navy-Yard in 1895–96 was $7.70 to $8.50 per cubic yard. Reference has been made to the low cost of concrete—$4.57 per cubic yard—in the locks of the Coosa River. It will be interesting to note why this special case has been used by the company as a means of criticising the board's estimate, when the Brooklyn Navy-Yard figures were so much more accessible, and when the work done at the Brooklyn Navy-Yard is so much nearer comparable to the other. It was smaller, and it was taken. In the locks in the Coosa River, in Alabama, referred to by the company, the low price is due, first, to the proportions used, which are 1 volume of cement, 3 of sand (instead of 2), and 5½ of broken stone, instead of 5.

You will observe that that proportion very much reduces the price of your cement, which is the expensive ingredient, and in doing that you have correspondingly diminished the strength of your concrete. That is one reason why that is cheaper. Second, the unusually low price of labor in that particular section of the South. It is in the heart of the pine region, and you can get labor, such as it is, for $1 a day. Third, the low cost of the staging and molds and the timberwork, the work being located in the heart of the Southern pine region, and the timber obtained from the vicinity suitable for the purpose. Another item is the omission of any charge for the use of plant. There is no charge for that, and if there were there is no profit in it. It is a Government job, and no contractor's profit. After you have added up these differences you will have the price quite conformable with the other. Furthermore, these locks were constructed in connection with navi-

gation on a river of inferior importance, and in no sense comparable to the tremendous constructions estimated for in Nicaragua.

Now, there are other items. We brought together all the information we could; wrote out to California; we got the cost of the concrete in the San Mateo Dam in California. The cost of the concrete in that dam is $8.

Mr. DOOLITTLE. At what time was that put in?

Colonel LUDLOW. I do not recall.

Mr. NOBLE. Within the last few years; I do not remember the exact year.

Colonel LUDLOW. The San Mateo Dam, in California, a very large construction of concrete, cost, per cubic yard, $8, as I have said, the proportions used being 1 volume of cement, 2 volumes of sand, and 6 volumes of broken stone.

The Betaloo Dam, in Australia, contains upward of 60,000 cubic yards of concrete, costing $10.16 per cubic yard, labor being $1.68 per day.

The large amount of concrete used at the Cascade Locks, in Oregon, cost $8 per cubic yard, with no allowance for profit, the work being done directly by the Government. The proportions for a large part of this work were 1 volume of cement, 3 volumes of sand, and 6 volumes of broken stone; for another large portion, 1 volume of cement, 4 volumes of sand, and 8 volumes of stone. A small proportion of the total amount was composed of 1 volume of cement, 2 volumes of sand, and 4 volumes of broken stone, the average containing a smaller proportion of cement than is proposed for the Nicaragua Canal.

The cost of concrete in San Francisco Harbor, in proportions of 1, 3, and 8, was $5.22, with no allowance for plant or profit. This concrete contained, relatively, a small proportion of cement.

Now, we will take, if you please, the contract price for concrete recently made at the Port Royal dry dock, on the Atlantic Coast. The proportions are 1, 2, and 5, the same as you are considering. What was the price? Eight dollars a cubic yard.

Mr. DOOLITTLE. That is the actual cost?

Colonel LUDLOW. Yes, sir; the actual cost. Now, at the Puget Sound dry dock the proportions are 1, 2, and 4, where gravel is used instead of broken stone, a material which may be regarded as somewhat inferior to broken stone, the cost is $7 per cubic yard.

Mr. DOOLITTLE. That is the contractor's price, is it not?

Colonel LUDLOW. It is the price the Government has to pay to get it done.

Mr. DOOLITTLE. It is the contractor's price?

Colonel LUDLOW. I presume it is a contract matter there.

Mr. DOOLITTLE. Yes; I know that particular case myself.

Colonel LUDLOW. Then that is all straight. It is $7 a yard. The contractor is going to charge a profit.

Mr. DOOLITTLE. That cement is brought around the Horn?

Colonel LUDLOW. I imagine you can get it cheaper there almost than you can on the Atlantic Coast, for some reasons. I know, as a matter of fact, by looking over the subject, that a ship in going to San Francisco, or some port on the Pacific Coast, brought with her as ballast a lot of cement and disposed of it at a very low figure, thereby lessening the expenses of her voyage.

Mr. DOOLITTLE. I would observe right here that these contractors made an exceedingly handsome profit.

Colonel LUDLOW. I am glad they made something. They do not *always. You* would not have them lose?

Mr. DOOLITTLE. Not being warm friends of mine, I would not.

Colonel LUDLOW. As a matter of fact, every employer of labor, such as an engineer or Government officer, dislikes it extremely if the prices are let so low that the contractor is going to lose money on the job. In such a case he requires too much looking after. We would rather he would have a reasonable profit, as the temptation then is not so great to cut corners off.

In connection with the $7 concrete at the Puget Sound dry dock, some of it cost $9.90, where it was difficult to handle, and in a very high proportion of 1, 1½, and 3 the cost was actually $13.58 per cubic yard.

At the New York dry dock (contract of 1890), the proportion being 1, 3, and 5, the contract price was $9 per cubic yard. That was in New York. What should it then be in Nicaragua? We said we would call it $9.50 there, because we believed with due economy and management and intelligent business arrangements it can be done at that price, but we won't be sure of it. Under the contracts of 1895 the Brooklyn price averaged about $7.70 per cubic yard, and in 1896 the work which is now being executed under the direction of the civil engineer of the Navy, who is in charge of that work, and really ought to know something about it, Mr. Menocal, the price is about $8.50 per cubic yard. The proportions in both cases being 1, 2, and 5, the same material that is in question in this case. That seems to me to be all the data we have on this question.

Mr. DOOLITTLE. Then I would like to ask you a further question. I see that for back filling you charge 70 cents per cubic yard. Now, I want to ask you how it is this filling would cost that much when the earth has been removed in the cut and the excavations made?

Colonel LUDLOW. Why, it is for putting the material back and solidifying it.

Mr. DOOLITTLE. That is, with modern appliances and every facility in the way of transportation, and all that?

Colonel LUDLOW. Always with the very latest methods, yes, sir; utilizing electricity even if found advisable. The material has to be filled in behind these walls and there solidified for the safety of the lock construction. It is not invidious, but if you will look at the estimates of the canal company you will find no estimate for that. They do not expect to back fill it, or else they expect someone to do it for nothing.

Mr. DOOLITTLE. What could responsible contractors be engaged for in this country to do that kind of work when the excavation was going on and the materials are being loaded on cars, and when the transporting of it is a simple matter?

Colonel LUDLOW. You know back filling goes in after you get your lock built. You can not do the back filling while you are making the excavation.

Mr. DOOLITTLE. But I mean elsewhere—in that immediate vicinity, as a good manager of such work would carry it on, to the best advantage?

Colonel LUDLOW. He would naturally use the material he took out, but he would have to take it out first.

Mr. DOOLITTLE. But there is other cutting going on in that immediate vicinity.

Colonel LUDLOW. In the lock?

Mr. DOOLITTLE. Yes, sir; in the immediate vicinity of the lock. Of course I understand in organizing a work you would organize it to use the material most advantageously.

Colonel LUDLOW. If I am not mistaken I think I have some notes on

that. You can understand how difficult it is to go into all these details here which we had to construct for ourselves. Seventy cents is a very good price; I mean it is a fair price to take. There is no question about it that our prices are all low.

Mr. DOOLITTLE. Leaving a good, big margin, would it not, for contractors?

Colonel LUDLOW. About 20 per cent.

Mr. DOOLITTLE. Do not you think this kind of work could be performed, under a well-organized scheme, in this country very much cheaper?

Colonel LUDLOW. I think so; yes.

Mr. DOOLITTLE. For half the money or less?

Colonel LUDLOW. It depends on the circumstances—the facilities for handling the material. You have not the facilities there except what you create, and the cost of creation has got to go in the unit price.

Mr. DOOLITTLE. But this construction and its organizing contemplates all that.

Colonel LUDLOW. Yes; the creation of these facilities; but who is going to pay for them, the company or the contractors? Who is going to pay for it? You can not eliminate an item of cost by saying the contractor is going to do it. Is he going to charge you for it? And here is an important point: When you sandpaper these things down, the conditions down there are practically unknown. There is not a contractor, with the possible exception of Mr. Treat, who understands the conditions there.

Mr. DOOLITTLE. You regard him as competent?

Colonel LUDLOW. Perfectly, on all these subjects which he has investigated and expresses an opinion on. I mean his own opinion, mind you, what he knows from personal knowledge, not as he is quoted. Take his own statement of what he thinks. Independent of that, what I want to say is this, that the extravagance of the work comes in when you are unable to define the condition so accurately that the contractor shall know what he is to do, and see in his own mind how he is going to do it. The more uncertainty you leave about the work, and how it shall be handled, the more the contractor is going to charge you for it, and he is going to charge you for the risk.

Mr. DOOLITTLE. Those elements of risk would be eliminated, would they not, so far as the minds of the contractors were concerned, before the contract was taken or the work undertaken?

Colonel LUDLOW. You say they will be eliminated. How? By information from the company? No such information exists. By personal experience of the contractor? Who is he?

Mr. DOOLITTLE. You would somewhat have it eliminated by carrying out a line of detailed surveys?

Colonel LUDLOW. Oh, surveys; always surveys. I would get the information, Mr. Doolittle, that is necessary to have to enable the contractor to bid intelligently on his work; that is, on the actual statement of the situation as it has been found to be.

Mr. DOOLITTLE. Would not the contractor inform himself?

Colonel LUDLOW. We want him to do it. If he would not, he would be unwise.

Mr. DOOLITTLE. Do you think any contractor would rely implicitly and exclusively on the estimates given him by the engineer of the Government?

Colonel LUDLOW. On the estimates—the statements of fact. That is what they do every day in this country, because, as a rule, the Gov-

ernment in works of this class makes as exhaustive an examination as they are able to make. Mind you, no contractor can go down there and take a contract to make that 3-mile cut.

Mr. DOOLITTLE. Is not it usual for contractors, before entering upon a work of this kind, to have these details ascertained by their own engineers?

Colonel LUDLOW. In advance?

Mr. DOOLITTLE. In advance of taking the contracts.

Colonel LUDLOW. Not always.

Mr. DOOLITTLE. Is it not usually?

Colonel LUDLOW. No; not necessarily. If it were a question of dredging a harbor or deepening a river channel, or making a 21-foot channel on the lakes where millions of cubic yards have to be excavated, the Government ascertains the quantity of the several kinds of material there and then shows the contractor the drawings and states to him what is there. Then the contractor bids. He does not make borings. He accepts the data that the Government furnishes. If you want a contractor to bid on the construction of that eastern divide, a 3-mile cut through a rocky range, you do not expect him to make borings there, which would take him perhaps a year to execute, at his own expense, and costing him probably thousands and thousands of dollars. It is your business to furnish to him that information which he can not readily obtain.

Supplementing that, suppose that he goes down to Nicaragua and stands out there in a 3-inch shower and thereby sees what effect such a rain would have on a gang of workmen in a pit with the water up to their necks and how much it would cost to have the necessary pumping arrangements to keep them from drowning. He is going to look after the construction of railroad and tracks. He is going to have his pumping apparatus provided for, make provision for his hospitals and where they will be and how accessible to the work, and he is going to get his provisions and tools. That is the kind of work he is going to do; but we would not expect him to bore for 300 or 400 feet through that mountain range there to ascertain the nature of the material. He expects to be told that. Suppose you want to make a contract to bridge the San Juan River, to make a channel in the San Juan River for the 30 miles of it——

Mr. DOOLITTLE. I suppose in a case of that kind you would be governed by the character of material as it turned out to be?

Colonel LUDLOW. As it turned out to be. The provision is different according to the different material. If there is a very large quantity of rock he is going to have a very large quantity of rock-drilling plant, but if there is a large quantity of soft material and little rock he might make shift to take out that rock, and his principal arrangement and plant would be to take out this softer material.

Mr. DOOLITTLE. Now, I think we have gone over this pretty thoroughly. I would like to ask you a question or two more on a different matter. Will you kindly state to the committee when you began this engineering work in a practical way? I do not think you had an opportunity to go over that when you made your first statement.

Colonel LUDLOW. What engineering work I have done? I was graduated in the corps of engineers in June, 1864, from West Point, and I was commissioned at that time. You want the uneventful history? How far back shall I go?

Mr. DOOLITTLE. At the beginning.

Colonel LUDLOW. I was born on the 27th of November, 1843.

Mr. DOOLITTLE. Oh, no.

Colonel LUDLOW. The hour I can not give you.

Mr. DOOLITTLE. Did you begin engineering work then?

Colonel LUDLOW. I do not remember. It's a long time ago. On that point my information is secondhand. I am assured, however, that it was a fact I began then.

Mr. DOOLITTLE. I do not know what it was——

Colonel LUDLOW. I presume it was some form of hydraulics. I have no doubt I engaged in the pumping business then and have been in it ever since. Since then I have put suction dredges to work on ocean bars.

Mr. DOOLITTLE. Is that an answer to the question?

Colonel LUDLOW. Perfectly. I would much rather that you would get it from the Adjutant-General's record. It would be much more complimentary than my record, as I would give it. What do you want me to tell you about—my engineering experience?

Mr. DOOLITTLE. Yes, sir.

Colonel LUDLOW. Well, I was doing a little engineering during the war—military engineering—mounting guns, building bridges, batteries, and defenses. You do not want that, do you? You might have to use it down in Nicaragua, but it is not included in the programme. After the war I was in command of an engineer company at Jefferson Barracks, and was practicing them as engineers in engineering work of various kinds, more particularly, of course, in military engineering and the construction of bridges. I do not remember all I did. I wish I had the record. I have been pretty busy, in a general way. After that I was ordered East as assistant to General Gilmore, a very eminent engineer and engineer officer, and was his assistant for five years in charge of fortification work and river and harbor improvement work, particularly through the South Atlantic from St. Augustine, on the coast of Florida, through Georgia, South Carolina, and part of North Carolina, and particularly in New York Harbor fortification work and river and harbor work at that time. I got together this hydraulic dredge, as Mr. Bates will tell you. It is quite interesting. I spent a summer in getting it together. It was used on the bar at St. Johns, Fla., for the first time. We were able to dredge off an ocean bar there at a less price than for still-water dredging. I was with General Gilmore five years, surveying and planning various harbors and other work.

Mr. DOOLITTLE. If you will just state your engineering experience——

Colonel LUDLOW. You see, it has been pretty much all the time engineering experience with me. For three years I was in Dakota on extensive reconnoissance work.

Mr. DOOLITTLE. For what purpose?

Colonel LUDLOW. The development of the country. I was with General Custer on an expedition to the Black Hills, on General Terry's staff. I was the engineer of the Stanley expedition, locating sites; among other things, locating the present site of the crossing of the Yellowstone River at the Northern Pacific Railroad. That was simply incidental. I was engaged in finding latitude and longitude and that sort of work. Later, I was ordered East, to Philadelphia, and was first assistant to Colonel Kurtz, of the Engineers, on the improvement of Delaware River and the construction of works in that district, including the pier at the entrance to Delaware Bay, and incidentally a survey which I made myself—a boat survey—of the greater portion of the Delaware River, from Trenton down.

Later, I was in charge of the work myself. Then I was transferred to Washington for the first time as the engineer secretary of the Light-House Board, and had charge of matters of light-house construction which were going on under the direction of the Light-House Establishment. Then, later than that, I was for three years in charge of the Philadelphia water department, by a remarkable combination of circumstances, in which the city councils of Philadelphia elected me to that position, and by virtue of a joint resolution of Congress, which is without precedent. I was authorized to accept the place without the loss of my commission, and the War Department gave me three years' leave of absence enabling me to discharge the duties of the place. When that three years was up, my leave of absence having expired, I came to Washington. I was two years Engineer Commissioner of the District of Columbia, and then for a short time I was in charge of the light-house district in Philadelphia.

Then for five years I was in Detroit, where I had charge of all the light-house work in the upper lakes north and west of Detroit, and also a number of lake harbors in Lake Michigan and Lake Huron. Then I was sent to London as military attaché of the embassy, and while there was detailed to come here, and was sent to Nicaragua with two other gentlemen to investigate this interesting Nicaragua Canal project. Then, having returned to London, I received instructions to make an investigation of the European ship canals, and later was instructed to return to this country and report to the Adjutant-General and Chief Engineer. Now I am trying to obey those orders and report at my station at Tompkinsville, N. Y., as engineer of the Third light-house district and with other engineering work in that vicinity. Meanwhile, I am discussing engineering points here.

Mr. DOOLITTLE. I think that is all I care to ask the Colonel.

Mr. PATTERSON. I have no questions to ask.

The CHAIRMAN. Does any other member of the committee desire to ask any questions?

Colonel LUDLOW. If there are no questions, there is a large amount of valuable information I have here which I would be glad to give to the committee on the subject of unit prices. In connection with the rock for the breakwater pier at Greytown which we had under consideration yesterday and Mr. Doolittle asked some questions about, I may state that $1.50 was the price for the delivery of that rock into the Greytown pier. We did not go closely into a computation of that kind; I admit we did not figure it up item by item, as we did other things, because it was a comparatively small thing. Furthermore, we found that we were prepared to accept the company's own estimate of the cost of that work, and, inasmuch as the company has not been accused of unduly expanding its items of cost, we believe that we would not be guilty of any extravagance in accepting their figures. Shall I proceed with the discussion of the unit prices?

The CHAIRMAN. Yes, sir.

Colonel LUDLOW. The subject of earth excavation above water is a difficult matter. There is a very large quantity of that.

The CHAIRMAN. Would you be willing to submit that and have it printed with your testimony, or do you prefer to read it?

Colonel LUDLOW. I really do not care about reading it. It is all of the same nature. The only object in reading it would be to let the committee see that there is not any source of information open to us that we did not draw upon, from Dan to Beersheba, from London to San Francisco, sending even to India to get treatises on the construction of dams there, *all of which is* extremely interesting.

Those India dams have no resemblance to this Ochoa Dam, as the illustrations will show, if you care to look at them. We wanted to know about the history of rock-filled dams, and we scoured the country for information on that subject. That is the way we investigated this matter, and the records show the attempts we made to get from every source information that was authentic. Now, I have here drawings of rock-filled dams in the West, which would be interesting to anybody to examine. They are cross sections, showing how they were built in the dry—built on rock foundations, with plank sheathing on the front; built of concrete cores on solid rock, with sheet-steel cores, and built with crib work. The drawings are very interesting. I will arrange to leave them for the use of the committee, if they desire to examine them; and I have also a roll of drawings of the Nicaragua Canal, showing the half dozen maps of Greytown Harbor, all of which are extremely interesting and running over the whole route of the canal from Greytown to Brito. We have all that complete.

Mr. PATTERSON. These maps were constructed by the board?

Colonel LUDLOW. They were made in the board's office in New York.

Mr. PATTERSON. Under the supervision of the board?

Colonel LUDLOW. They are mainly taken as transcripts from the maps in the canal company's office. That was our main source of information, you know, but there are some things which were quite original with us. For example, the survey of Greytown Harbor. That is new and complete. We could not have done it ourselves. We had no time, but the officers of the U. S. S. *Montgomery*, in accordance with the instructions of the Secretary of War, made the offshore part of the work after we gave them their base line to start from. They did the boat work afterwards. That map of Greytown Harbor is the most complete ever made.

Mr. PATTERSON. I would like to ask if it is the purpose of the board to submit all these details to the committee?

Colonel LUDLOW. It has been, sir. This is part of the matter submitted to the President in our report. It is part of the official record. This is only a retained copy I kept for my own use, the originals having been turned in.

Mr. PATTERSON. And with the Public Printer at this time.

Mr. BARTLETT. Does that include the paper you are about to read now?

Colonel LUDLOW. Oh, no, sir; this paper was specially prepared for the use of this committee.

Mr. PATTERSON. You have spoken of your experience as an engineer. Lieutenant Endicott, I believe, belongs to the Navy?

Colonel LUDLOW. I believe he is the senior officer in his corps of the Navy.

Mr. PATTERSON. What is his standing as engineer?

Colonel LUDLOW. I am not familiar with the detailed history of the civil engineers in the Navy, but the mere fact that he is their senior officer, and detailed at Washington itself, at the headquarters in the Department, is a sufficient indication of the consideration which attaches to him in the Navy Department.

Mr. PATTERSON. He is the senior engineer in the service?

Mr. ENDICOTT. As far as detail goes. There is one senior to me on the list in date of appointment.

Mr. PATTERSON. You have represented, and do now represent, no other interest except the public service in this matter?

Colonel LUDLOW. Yes, sir; and the general engineering interest of the country. We had no other object in view.

Mr. PATTERSON. Have no interest either in the canal or against the canal?

Colonel LUDLOW. What kind of interest?

Mr. PATTERSON. Personal interest?

Colonel LUDLOW. Nothing except as a professional investigator; nothing except as an engineer. I have no pecuniary or commercial interest of any kind. My predilection, as I have told the committee, is entirely favorable to the project, you understand. I would like to see the American engineers have a chance to show what they can do toward building a ship canal. The Frenchmen and the Englishmen and the Germans have all had a chance, and now I would like to see what the American engineers can do.

Thereupon the committee took a recess until 2 p. m.

The committee met pursuant to adjournment, at 2 p. m., Hon. William P. Hepburn in the chair.

STATEMENT OF HON. WARNER MILLER.

Mr. MILLER. Mr. Chairman and gentlemen of the committee, I should not have asked to be heard again upon this question had it not been that several statements that I made when I was last here have been called in question by Colonel Ludlow, particularly my statement in regard to Mr. Treat's offer to build the entire canal, and also the statement that I made in regard to Engineer Donaldson, of London, and also some other matters which I had stated in regard to the prospective cost of this work. I assumed that my mere statement of what those gentlemen had told me and had done would be accepted by the members of this committee, who know me personally, without any further proof, but as the truth of my statement has been called in question I have come here to-day, I think, fully prepared to prove the truth of what I stated when I was last here.

Before proceeding to the documentary evidence which I have, I have a few words to say in regard to what I have heard since I have been here for two days and what I have heard of the statement as given by Colonel Ludlow. Before yesterday I had assumed that engineering was an exact science, as much so as any science could possibly be, but if the statement made here yesterday as to the methods by which the estimates were arrived at in the matter before the committee, and also in regard to other great works throughout the world, then the science of engineering becomes chiefly a science of guessing, and the engineering schools at West Point and elsewhere ought to be designated "schools for the teaching of skillful guessing."

If that be true, then, Mr. Chairman, I think I am just as competent a guesser as anybody else. One of the first things I ever did to make money was to reconstruct a damaged canal. There was no engineer in that part of the country, and I went over it and made a guess as to what it would cost and made a bid on it. The bid was accepted, and I completed the work and made a very handsome sum of money. I have been successful thus far in life in making close guesses as to building mills, hydraulics, dams, and that sort of thing.

But, Mr. Chairman, I do not believe that the science of engineering is mere guesswork. Now, what are the facts? A company properly organized sent out a corps of engineers to make surveys and examinations in Nicaragua. They spent a greater part of the time for three or four years engaged in that work. The company never claimed that all the engineering work was done and that nothing more was to be known,

for everybody knows that in the construction of a great work like that the engineering, after the plans are made, is one of the great items of expense, continuing through the entire work. But the company thought that they had obtained information enough to enable them to make a close estimate of what the work would cost, and also to present plans which when submitted to competent engineers would meet with their approval, and it was this work in which the company engaged for several years before it began any construction whatever. It did submit these plans to several engineers, as I have stated here before, and they were approved.

The action of the Government in regard to this matter I need not go over again, because I went over that very fully at my last hearing. Some enemies of the enterprise and some of its friends thought it wise to have a further investigation by a commission of engineers, and for that purpose they appropriated $20,000 and authorized the President to appoint them and send them down. He did so. The company met the commission with perfect frankness and spent nearly $20,000 in putting the work in shape so it could be examined by this commission, and turned over to them all the data that they asked for that we had, and in every way undertook to aid the commission in its work. The result you have before you in a report, of which I need not speak and will not. In many things I agree with it and in some things I do not.

But it has fallen to the lot of Colonel Ludlow, who is chairman of this commission, to come here before this committee and state substantially in terms repeatedly that what we had done was worthless; that there was not sufficient information or data upon which to form any idea as to what this work would cost, and to further pronounce the plans of the company absolutely impracticable. With that statement before us, of course it behooves both the chief engineer of the work, who has given the better part of his life to it, and myself, who was president of the company during all those years, to say whether this report can be verified by any facts, if not by this investigation of the company, by any facts obtained by the commission itself.

First, the commission tells us that there is not sufficient data upon which to make any estimate of the cost of this work, and then they proceed to make a detailed estimate, going into details of all kinds, and they find it will cost a specified sum—I believe 133,000,300 and some odd dollars. By what process of reasoning or logic this was arrived at without any data I do not know. Colonel Ludlow has told you repeatedly they went through the country, looked at the line of the canal, and did substantially no engineering work except to take a few levels upon the lake and upon the river, and that the officers of the steamship *Montgomery* made a survey of Greytown Harbor; but certainly there was no attempt to verify the findings of the company by actual work in the field to determine whether our lines were correct or not, to determine whether there was a mistake of a foot in the levels between Greytown and Ochoa Dam, as Colonel Ludlow stated yesterday.

As to that, I will leave that for our chief engineer to answer. It was rather gratuitous, I think, to call in question the truth of the statements I made or to say in a most positive manner that no other engineers had ever been over the line of this canal save these three commissioners. That was a statement no man could make positively, because there could be no proof of it whatever. No man has been there all the time during all the years that Mr. Menocal has been there, and no man could make any such statement as that with any truth; but when asked to tell who gave him this information we find it comes

from a discredited employee of the company who I myself relieved from authority and turned out of the company when we found that while in our service in Nicaragua he had undertaken to seize the property of the company, and brought suits in the courts in Nicaragua, where he was finally defeated because his claims were fraudulent.

The Commission did not ask me or anyone in the company to give them the names of any competent engineers on this work, but they took this man—they say the first that offered. If they did not know his character, they could have found it out. They did not come to me to find it out. Major Davis, one of the best officers in the Army of the United States to-day, in the Secretary of War's office——

The CHAIRMAN. Please give his initials.

Mr. MILLER. Maj. George W. Davis. All the time I was there he was the general manager and had to do with these men and knew them. If a brother officer asked him about the character of a man in the employ of the company, he would have found it. I do not attempt to say that this Commission deliberately selected this man, knowing his relation to the company, or held correspondence with other men who had been discharged, but it is a fact that they did, and then to put the statement of the president and chief engineer of the company against this man is hardly in keeping, sir, it seems to me, with the proper conduct of an army officer. However that may be, certainly it is not in keeping with common decency among gentlemen. That brings me here to prove the truth of the statements that I have made.

Now, fortunately, Colonel Ludlow has spoken in the highest terms of Mr. Treat. I am sorry Mr. Treat is not here. When I came to Washington and heard that the statements that I had made had been called in question I telegraphed to Mr. Treat in Chicago, asking him to come on here, and he replied that he could not possibly do so, as he had important business engagements in California and was to leave that night. What he said in regard to this matter, however, I shall read when I come to it, at the proper time. Mr. Treat, some years ago at the beginning of this enterprise, had his attention called to it—I know not how—but he went to Nicaragua and spent several months, I think, in making investigation of the country, the people, the climate, and conditions along the line where the canal would have to be built. He then came home and when the company began to talk of commencing work Mr. Treat brought himself in communication with the company upon a proposition that he would undertake to do some of the work. The company was not in funds to undertake large contracts at that time, but we had, under our concessions, to expend $2,000,000 during the first year, in order to hold the concessions, and I proposed, as one of the first things to do, to build a railroad from Greytown into the interior, into the foothills, in order that we might arrive at the Great Divide and at the locks, because the length of time it would take to excavate the divide cut would determine the length of time it would take to build the canal.

The difficulties of building that railroad I have expressed in my former statement here. Suffice it to say that Mr. Treat consented to go down and build that railroad, he himself furnishing the skill and ability and the company all the labor and material, and he to receive the 10 per cent for carrying it through. He did so, and with great success, and built the road for a little more than half of the estimate of our own engineer. After he had returned to New York, and we were considering the question of raising funds in a large way by a probable issue of bonds, I asked Mr. Treat to write me a statement as to the

general condition of affairs down there and his ideas of the country and of the ability to do work and everything, in order that I might have it to show to bankers and other people who might be interested in it. I propose to read this letter first:

22 EAST SEVENTY-EIGHTH STREET,
New York, February 27, 1892.

Hon. WARNER MILLER,
President Nicaragua Canal Company, 44 Wall Street, New York.

DEAR SIR: Concerning the cost of the Nicaragua Canal, if built by intelligent and experienced contractors and engineers, there is not much that I care to say, as the ground has been so fully covered by the engineers' reports and estimates.

Most of the special difficulties, as well as facilities of construction, will occur to anyone experienced in doing heavy work who goes carefully over the canal line; and almost anyone will certainly be surprised at the absence, to a degree, of so much of the difficulty expected in tropical countries. This is especially true of the Pacific division of the canal, but it is also true, to a less degree, of the Atlantic division.

As you know, I do not speak of this without some knowledge, having been in Nicaragua at all seasons of the year and knowing the route of the canal thoroughly.

One of the common causes of the difficulty and expense of building heavy public works in the Tropics is the ill health of the countries and the sickness and high death rate among the workmen. This cause is almost wholly absent in Nicaragua, and in this respect I believe the eastern end of the canal may have an advantage over the western end. The northeast trade wind, which blows nearly all the year, is stronger and fresher along the line of the canal from San Juan del Norte, through the notch in the mountains over which the line runs, and on to Ochoa, than it is west of Lake Nicaragua.

But I believe all people acquainted with the country along the canal line from the lake to Brito, on the Pacific, consider it healthful. There can hardly be much disagreement as to that. No part of Nicaragua near the canal line has ever been subject to epidemics. My own experience in building the railroad for you from the harbor at San Juan del Norte, 10 miles across the swamps to the higher ground beyond, is proof of the healthfulness of the country along that part of the line.

There can scarcely be a more unhealthful piece of work during the construction of the entire canal than that was. More than half of the men employed worked in the swamp in water from their knees to their shoulders, ten hours a day, doing hard work and not always having quite the proper food, which can constantly be had after the canal work is fairly started. And yet, out of about 1,000 laborers employed for seven months, only two died of disease.

The men worked steadily. Every morning they commenced at 6 o'clock and, except one hour from 11 till 12, they worked till 5 in the afternoon. They then had some daylight still remaining to wash their clothes, bathe, etc. They did not stop for rain, but worked steadily through the rainy season without protection while at work, all the time during the seven months except two half days. There was malarial sickness; it could hardly be otherwise, but there was nothing, except the two cases mentioned, which was not cured in a week or so by rest and the proper medicines. At the end of the seven months the men generally were in as good health as at the beginning. They were mostly Jamaica negroes. There were from 200 to 300 native Nicaraguans and Costa Ricans, and a few negroes from the United States and from several of the West India and Windward islands.

I believe the matter of health, as affecting the difficulty and cost of construction of the canal, need hardly be considered more than in estimating the cost of work in almost any part of the United States.

The labor supply will be one of the first things to be considered by anyone undertaking the work or a part of it. I can speak with some intelligence concerning that also, one reason for my undertaking to build the short railroad across the swamp having been my desire to study the health of the country and the question of the supply of labor for the construction of the canal. I am satisfied that a constant force of 10,000 to 15,000 men or more can be kept on the eastern end of the work from the island of Jamaica alone. These men are good at task work and are fairly good in large gangs under foremen. A small number of engine drivers, excavators, and steam drill men, etc., can be had from the same sources, also a good many rough masons and carpenters. They will do good work as stokers on all steam machinery. An abundance of skilled labor and foremen for both divisions of the canal can be procured from the United States and from Europe with no trouble and without paying very high wages. For the Pacific division of the canal I believe plenty of common labor can be found in the various States of Central America. I have found these laborers fairly efficient under good management. The rates of pay, including

subsistence, on the whole canal will probably be little more than half the average paid in the United States and I should say the efficiency of the laborers was also about half that of laborers in the United States.

This was written when silver was much higher than now, when the sole was worth about 75 cents on the dollar. Now it is only worth 45 or 50, although the rates of labor in the country remain the same.

The installation of the working plant on the eastern division, including the building of additional necessary railroad, will be expensive and will add considerably to the cost per cubic yard of the work. But, on the other hand, steam coal from Alabama or from Wales, and timbers and lumber from the Southern States, will be cheap.

On the western division fuel and lumber will be more costly, but the expense for them can be closely estimated in advance.

When I commenced work on the railway at San Juan del Norte, the cost of discharging freight, especially heavy machinery, as locomotives, was greater than the cost of transportation from New York. Now, I understand, vessels can be unloaded directly on to cars at the entrance to the canal.

At that time the harbor was opened and vessels drawing from 12 to 14 feet of water went into the harbor without difficulty, and the cargoes were unloaded directly on the wharf.

For the Pacific division, lighterage will be necessary until the harbor work at Brito is finished, but during a large part of the year vessels can lie safely at anchor there in the lee of the land, the wind being uniformly from the eastward except for two or three months. In case of necessity the excellent harbor of San Juan del Sur, 6 miles away, can be used.

Any engineer or contractor examining the work will be soon impressed by the fact that it is "both way" work, i. e., that a large part of the excavation is to go into the embankment instead of being wasted, and that no material whatever need be borrowed for dams or embankments. This will reduce the unit cost of the work very materially.

The thorough examination by borings which has been made shows clearly the character of material to be handled for the whole length of the canal, and it is such that little allowance need be made for slides. The only uncertain part of the work would seem to be the foundations for some of the dams and embankments. If masonry structures were to be erected this would be a very serious matter, but since permanence is to be secured by the mass and weight of "rock-fill dams," rather than by any form of masonry construction (as I understand has been decided), this becomes merely a matter of dumping onto the dam or embankment so much more or less of the material from the cuts and wasting less or more in more convenient places. In any contingency there will be enough rock excavation from the great cutting of each division of the canal to make the dams and embankments of the same division, and to make them as durable as the adjacent hills.

There is a large amount of dredging to be done at the eastern outlet of the lake, but the material there is a soft, thin mud, which can be moved by suction dredges similar to those used in filling the Potomac flats at Washington, in filling in tide flat lands at Tacoma, and in similar work elsewhere, for a very small cost per cubic yard. The dredging to be done at either end of the canal is like that done at Colon by bucket dredges and also in other places. The cost of the concrete and masonry for the locks can be approximately estimated, and the steel work for the gates can be made anywhere in the world where it can be had most cheaply. The harbor work at San Juan del Norte is already well under way, and the correctness of the engineers' plans and estimates seems to be demonstrated.

The problem of the harbor at Brito is apparently more simple than at San Juan del Norte. It is such work as has been already successfully done elsewhere.

I should say the estimate per cubic yard for earth excavation on the eastern-divide cut was too low, but that is comparatively a small item.

The work is one which offers ample opportunity for experience and skill and the careful management of large forces of men in its accomplishment, and its cost will be largely affected by these agencies. There will be plenty of chances for trying costly experiments in construction, and millions can be quickly spent in following wrong methods of work without doing much toward the completion of the canal; but it seems to me that the work can be done on the whole canal for about the unit prices estimated by the chief engineer and give the contractors fair profits.

Assuming that the quantities throughout have been accurately calculated, the canal should be built for considerably less than $100,000,000.

Very truly, yours,

C. P. TREAT,
Office, Rookery Building, Chicago.

This was in 1892, Mr. Chairman. Mr. Treat was frequently consulted with by myself and the company in regard to this matter, and last year, when an effort was being made in London to interest some English capital in this enterprise, the desire was expressed to have bids made for the entire work—to find some engineers or some contractors of sufficient capacity to make a proposition for the entire work. Mr. Treat before this had made a contract bid for the entire western end of the canal. He said he preferred to have that; that he was capable of carrying on that amount of work himself, without help; that he would give abundant security to the company for its completion; and he made a bid for the western end of the canal, which was read here yesterday, and of which I have a copy which is substantially correct. The company desired him to go further than that, and to see at what price he would be willing to build the entire canal.

This statement was made while he was in London. I simply knew of it by the reports brought to me by Mr. Smith M. Weed and Mr. Bartlett, who were there, and I made that statement in perfect good faith and truthfulness, as it will appear. When I heard it had been disputed in this committee that any such proposition had been made in any form, I immediately telegraphed Mr. Treat in Chicago and received telegrams from him, which I need not read because they are repeated in this letter, but I will read the entire letter. This is not the bid which was read here yesterday, the one I am reading about now. It was a lump-sum bid for the western end. He first made the bid in detail, which was read yesterday, and then this lump-sum bid.

Mr. DOOLITTLE. What Bartlett is that?

Mr. MILLER. He was the chairman of the reorganization committee. When the Canal Construction Company went into the hands of a receiver a reorganization committee was formed to reorganize the company, and Mr. Bartlett was made chairman of that committee; and when the company was reorganized and the new company was started Mr. Bartlett was for the first year president of that company, of which I was the chairman of the board.

This bid, then, is a lump-sum bid for the western end of the canal, taking all the risks himself as to quantities and material and the possible results. He says:

CHICAGO, *May 2, 1896.*

HON. WARNER MILLER:

DEAR SIR: I have received your telegram. I leave to-night for California.

I replied as follows:

I would agree to build the western division of the canal and put a ship drawing 28 feet from the Pacific Ocean into Lake Nicaragua for $31,000,000. Have no doubt syndicate or individual could build entire canal for $100,000,000 and make large profits.

This was a lump-sum bid, he taking all his chances.

Never made formal proposition for entire canal. Told Bartlett would be willing to undertake it for $100,000,000. Made him formal proposition for western division for $31,000,000, which I hereby confirm. I inclose herewith a copy of bid which I made to Mr. Bartlett in 1895 for the western division, based on unit prices. I also at his request made him a bid last winter in London to build the western division for a lump sum of $31,000,000, subject to certain conditions of payment as specified in the proposition. Colonel Ludlow and the other members of the Commission saw a copy of my bid of 1895, and we discussed the unit prices. I think they did not consider any of my prices too low, except the item for concrete. That they questioned and were doubtful about. Of course, my bid does not in any way guarantee quantities, but those were closely determined by the surveys. Any man who can run transits and levels can do that. The chiefs of parties and their men whom I saw and knew in Nicaragua were entirely competent to do their work.

As to the character of the material and the liability of the slopes to slide and increase the amount of excavation, I knew personally of the borings being done over much of the canal line including the eastern divide cut, and have samples of the rock in my Chicago office which I obtained while the borings were being made. There can be no danger of extensive slips on the western division, and I think very little danger on the eastern division. The clay overlying the rock on the eastern divide cut is of the same nature as that through which the cuttings were made for the railroad, and these cuts have stood perfectly until now. Under the clay the borings showed solid rock to the bottom of the cuts.

I would be willing to undertake the construction of the entire canal now for $100,000,000, except that I am not ambitious to assume such a heavy load. I should have to consider it somewhat. I have no doubt that better men than I would undertake it.

Yours, very truly, C. P. TREAT.

I submit, Mr. Chairman, that that justifies all I said in regard to Mr. Treat's proposition to build the entire canal. But that was not all; we sought bids from other people, both for the dredging and the excavation of the work, and I hold in my hand a bid made by James P. McDonald & Co., of date July 23, 1895, for the construction of this canal. I need not say, perhaps, to those who understand it that McDonald & Co. are among the largest and most successful contractors in this country. At the present time they are just closing up the building of a railroad in Jamaica in which they have been engaged for several years. It has been under contract for at least five years, but abandoned by other parties and they took it up. I visited myself and went over some 60 miles of the road. These people would be backed by very large capital.

80 BROADWAY,
New York, July 23, 1895.

JOHN R. BARTLETT, Esq.,
President Nicaragua Canal Company, New York City, N. Y.

DEAR SIR: I understand from recent conversations with you that your company will shortly be able to be in a position to proceed with the work of construction of the Nicaragua Canal. In accordance with those conversations I herewith make the following preliminary tender to you:

We should be willing to undertake the work at substantially the prices named for the different classes of work by Chief Engineer Menocal in his report on the final location of the canal, dated January 31, 1890, of which you furnished me a copy, with the following exceptions: We should want, instead of the prices given by Mr. Menocal, to be paid at the following rates:

1.	Clearing	per acre..	$150.00
2.	Rock excavation	per cubic yard..	1.80
3.	Earth excavation	do....	.50
4.	Earth fills	do....	.50
5.	Earth under water	do....	3.50
6.	Rock under water	do....	4.00
7.	Concrete in place	do....	10.00

The rest of the work described in Mr. Menocal's estimates we are prepared to execute at his figures, which, with the changes therefrom last above referred to, would make the total amount for which we are prepared to build the canal $70,000,000.

This proposal is made in respect to the whole canal. It can be made to apply pro tanto to the eastern section thereof, from Greytown Harbor to the lake, thus excluding the work covered by the proposals which I understand you have already received for the dredging and for the construction on the western coast. I should prefer, however, to make one contract, covering the entire work of the canal.

I shall be prepared to give satisfactory bonds for the faithful performance of the work within five years from the date of the contract.

It would be necessary for you to arrange that payments should be made monthly, either in New York or Greytown Harbor, upon certificates of work done or materials furnished, approved by the engineers of your company; and I am prepared to take these contracts for 50 per cent in cash and 50 per cent in bonds of the canal company, at such price as they may be issued to any other contractors or syndicate or in any other way disposed of by your company; or, if you choose, I am prepared

to make the contract for cash, and I will contemporaneously agree to subscribe for an amount of the bonds in any syndicate which you may prepare which will be equal to half of the amount to be paid me upon the whole contract, with its pro rata of stock.

I shall be prepared to enter into a formal and detailed contract with your company whenever you are in a position to satisfy me that your financial arrangements have been so far perfected as to insure the receipt by me of the cash necessary to be paid under this contract.

I ought to add that I am at present engaged under contract in the construction of a railway on the island of Jamaica, and I expect to finish that work about the first of the year. I am now employing there about 8,000 men, with a large plant, and if any contract is to be made with you, I should desire to have the same perfected before the first of December, if practicable, so as to arrange for the transfer of my force and plant directly from Jamaica to the Isthmus. I feel safe in saying, if you can show me that your financial arrangements have been consummated, I should have no difficulty in putting a force of 25,000 Jamaicans alone at work upon the canal within ninety days from the date of contract.

In accordance with our conversation I have made this letter general in terms, but I think, with the modifications of Mr. Menocal's figures above referred to, it is sufficiently specific to be the basis of a formal contract for the construction of the whole or a part of the canal, if you accede to my terms.

Yours, very truly, JAMES P. MCDONALD & CO.

TUESDAY, *May 5.*

Mr. MILLER. Here is the proposition made for the dredging by A. B. Bowers, the inventor of the suction dredge—the one which has been used so long at Tacoma and on the Pacific Coast. This was made in 1894.

MURRAY HILL HOTEL,
New York, May 25, 1894.

JOHN R. BARTLETT, Esq.,
Chairman Reorganization Committee,
Nicaragua Canal Construction Company.

DEAR SIR: Referring to and confirming my letter to you of April 14, 1894, I desire to say that since receipt of your reply I have consulted with my associates, Messrs. Hamilton, Williams, and Bliss, of Nevada, and others, who authorize me to make the following proposition, to which we desire your acceptance at as early a date as practicable.

We desire to join in the syndicate you are organizing for the construction of the Nicaragua Ship Canal and hereby offer to contract for all the dredging on the canal, including both harbors, under the estimates made by Chief Engineer Menocal, bearing date January 1, 1890, and amounting to about $9,000,000, on the following terms, to wit: Payment to be made all cash, or at your option 20 per cent cash and 80 per cent in the 5 per cent gold bonds of the Maritime Canal Company. Both cash and bonds to be paid us in pro rata monthly installments as the work progresses. The bonds to be taken at 70, or at such price as other contractors may accept the same, or at the lowest price for which the said bonds are sold by the company at any time prior to the final completion and opening of the canal. It is understood, however, that this contract shall be binding on neither party until other contracts to be executed simultaneously with the dredging are taken on substantially the same terms, and of equal amount or sufficient amount to insure a vigorous prosecution of the whole work, and ample security given for the payments of cash and bonds as aforesaid.

Should you award us the contract we will give sufficient and satisfactory bonds for the performance, within four years from the commencement of the work, of all of said dredging, and will commence preparations for the active prosecution of the work as soon as the final contract is formally executed. I will request my associates above named, and perhaps others, to write you approving the above proposition.

Yours, very truly,

A. B. BOWERS.

CARSON, NEV., *June 4, 1894.*

JOHN R. BARTLETT, Esq.,
Chairman Reorganization Committee,
Nicaragua Canal Construction Company,
2 Wall Street, New York, N. Y.

DEAR SIR: Referring to a proposition made to you by A. B. Bowers, esq., and dated May 25, 1894, wherein he, for himself and associates, agrees to contract to do

all the dredging work required for the construction of the Nicaragua Ship Canal under certain terms and conditions mentioned in said proposition, we desire to say as his associates in the enterprise that we fully indorse and approve said proposition, and that we will, in conjunction with Mr. Bowers, do all and everything that is necessary to carry out any contract entered into with the said canal company based on the proposition mentioned.

Yours, truly,

B. WILLIAMS.
H. M. GORHAM.
D. L. BLISS.

Mr. MILLER. Now, Mr. Chairman, we present these with the belief that they are far more important than any estimates that can be made by anybody as to the unit of prices. They are made by gentlemen who are engaged in this business, who know it thoroughly, one of whom has spent a long time in Nicaragua, and the other firm, McDonald & Co., has been engaged in this work in the Tropics, and they understand fully what it means. Now, the statement is made unequivocally by Mr. Treat that the cost of labor, that is the per diem cost of the men, is about one-half what it is in the States, and that they perform one-half the amount of labor which would be performed in the States. In other words, that the labor cost in removing earth or doing any other labor, that the unit of cost would be precisely what it is in the United States. At the present time with the present low price of silver it is even less than that. Mr. Treat's experience of seven months in building this railroad ought to be the best possible testimony that can be given in regard to a matter of this kind, and in another letter which he wrote me of the same date, May 2, in regard to labor, he said:

I told the Commission——

Mr. DOOLITTLE. What commission does he refer to?

Mr. MILLER. He refers to the Commission of which Colonel Ludlow is the chairman.

I told the Commission that I considered the labor a little more than half as efficient as in the United States and the rate of pay was half as much. I never had more faithful workers than the natives of Costa Rica and Nicaragua.

It was stated here yesterday that the labor of the South American States, Nicaragua and Costa Rica, was worthless; that they would not work. Mr. Treat said he had two or three hundred hands employed all the time.

I never had more faithful workers than the natives of Nicaragua and Costa Rica and the Jamaicans were not bad. I expect to be back in three weeks and would be glad to come to Washington then if not too late.

Now, the position taken by the company is this, that labor in Nicaragua costs about one-half what it does in the United States, and it is about one-half as effective. If I recollect aright the report of the Commission, they make a similar statement, but now they make the statement that the cost of labor in Nicaragua is twice what it is in the United States. Now, the prices paid are well known——

Mr. DOOLITTLE. I would like to call attention to the fact that it was stated here yesterday in one statement which was made that it was about one-fourth?

Mr. MILLER. I will come to that. It amounts to that when we come to it, and you say it costs twice as much.

Mr. PATTERSON. I did not understand it that way. I understood Colonel Ludlow to say that when a given piece of work was to be done that the labor cost of the performance of that work was twice as great there as it was here?

Mr. MILLER. That is my understanding, and that is what I stated or intended to say.

Mr. PATTERSON. And the climatic conditions——

Mr. MILLER. Everything approaching to it. Mr. Treat, however, says, as I have just read in his own language, that the cost of labor in Nicaragua is about the same as it is in the United States—that is to say, you pay one-half the price per day for a man and get one-half the amount of labor. That makes it the same, as you can readily see.

Mr. DOOLITTLE. Mr. Treat is strongly indorsed in regard to that matter; he is said to understand all about these conditions?

Mr. MILLER. I asked the secretary of the company to make up from our books a statement of what we paid for labor during those days.

Colonel LUDLOW. Mr. Chairman, may I say a word there merely to explain what the position of the Commission is?

Mr. DOOLITTLE. I think there will be opportunity after this.

Colonel LUDLOW. I will only take two minutes.

Mr. MILLER. I have no objection to that, although I have to get away on the 4 o'clock train.

Colonel LUDLOW. If there is no objection, it is this: The belief and statement made by the board is not especially with reference to labor alone or cost of hiring it or effectiveness alone, but the unit of the cost of work done, taking into account all matters, is twice at Nicaragua what it would be for the same work in the United States. The comparison covers every consideration affecting the cost in Nicaragua.

Mr. MILLER. I understand that to be the statement made by the commission, and I understand also the statement was made here yesterday, very deliberately, that the labor cost of any piece of work, taking the labor by itself, was twice what it was in the United States. The secretary of our company says:

> We paid colored laborers from Jamaica 20 soles per month and subsistence. Occasionally we paid 25 soles and subsistence, but I take it that was for local native labor. Twenty soles and subsistence was the contract price. In estimates subsistence is counted at 14 soles per month. So far as I can discover it actually costs 11.50 soles only. This would make labor cost from 31.50 to 36.50 soles per month. At that time soles were worth about 72 cents; the equivalent in American money would, on that basis, be $22.68 to $26.28; to-day soles are worth less than 50 cents.

You see this is less than one-half what is paid in this country, decidedly so anywhere. The cost of labor on the Chicago Drainage Canal to-day is for common labor of this same kind $1.50 and the man finding himself; that is, in gold. Now, in estimating the cost of a piece of work employing eight or ten thousand men it is important to know what proportion is skilled and what proportion is common labor. I telegraphed this morning to the chief engineer of the Chicago Drainage Canal and this is his answer:

> Report of August, 1895, shows 77 per cent of unskilled labor on the Chicago Drainage Canal.

Now, Colonel Ludlow stated yesterday, and unadvisedly, I think, that one great cost of labor down there would be the necessity of keeping a large number of relay men on hand. He said a double set of men, so if a man running a steam engine or dredge was taken sick, they could not wait and send to New York for another man, but should have some one else on hand. Let us see about that as practical men, and I have employed a good many men. If this work was going on quite extensively, there would be from 50 to 100 locomotive engines at work. There would be perhaps 100 or more steam engines used for hoisting and drilling and all kinds of work. There would be a large number

of tugboats and other steamboats on the water. There would be, all told, from 100 to 200 and 300 steam engineers on this whole work from ocean to ocean.

Now, it goes without saying there would not be any necessity for doubling all those employees. It is not done on any railroad in this country. They keep a few extra engineers, and when a man is sick another man takes his place, but that does not cost the company anything except the relay men, because when a man goes off work and does not do his duty he does not get any pay, and out of this vast number the relay men who would have to be maintained would not exceed those maintained upon a railroad or any great work in this country. I simply want to bring out the fact here that Mr. Treat, who is so far altogether the best authority upon this question of labor, and has the most experience with it, holds here, as I have read to you, the cost of labor in Nicaragua, the cost of the unit of labor for work, is precisely the same as it is in the United States.

Now, what other costs are there down there which would be greater? In the first place, we do not pay anything for the right of way, we do not pay anything for the material, nor do we pay anything for the timber taken off the public lands. It is all given to us. We do not pay anything for rock or sand or anything we want there, and when we import things from abroad, we have the right to bring them in there without duty. Our rock-cutting machinery, hoists, and other machinery are bought in this country or in England, at the very lowest possible price, and they are delivered at Nicaragua at not exceeding what it costs in this country. For instance, you can carry your flour and all provisions from New York or New Orleans for less money per barrel of flour, or barrel of pork, or barrel of rice, than it costs to bring a barrel of flour from the great mills of Minneapolis to New York. We did it there for a while, and I know what it costs. The average cost of supporting all these men when we were working as high as 1,600 was a little less than 30 cents a day, and they were well fed and housed and cared for, and we sent them clothing down there bought in the cheapest market in the world and sold it to them at what it cost, and they were entirely satisfied with it. There is not a single item there—take, for instance, the item of cement; portland cement would be taken there from Belgium, England, or Germany. There are large works in Belgium, and let us see in regard to that.

It was stated here to-day, in giving prices upon which the Government was having concrete work done, that cement cost a certain amount laid down at the works, but in every case that included duty paid upon the cement in this country; but that cement is brought into Nicaragua, if we use it on the canal, without paying any duty. Let us see what cement costs. We have used some there. The price of portland cement in bond varies according to the brand. This was written the 15th of February, and the price then was $1.75 to $1.83 per barrel—that is, in bond, duty unpaid. In 1889 and 1890, when Mr. Menocal made his last estimate, it ranged from $1.90 to $1.95.

Now, this cement can be put in Greytown in shiploads, as it will have to be, of course, just as cheaply as you can put it in New York or any port of the United States, and it is put in there without duty, and the duty upon portland cement in barrels is 8 cents per 100 pounds, and therefore you have got to add to all these prices upon works in the United States the duty upon the cement. In short, there is not a thing required in Nicaragua that will cost more there than it will cost in the United States, and so far as iron and machinery of all kinds is concerned it

goes in without duty, and it can be taken here from the United States, or it can be taken from Europe if it can be bought any cheaper there. The company is under no obligations to go to a particular country for its material, and I submit that there is not a single item entering into the cost of this canal of that kind of iron work—finished machinery—dredges, for instance, which would not be built there. They would be built here or on the Clyde, and the locomotives would be built here and transported, and when the harbor is opened the cost of freight from New York to Greytown is not nearly as much as it is from Chicago to New York delivered by rail, or even by water.

Now, it is admitted that the climate is not as good there as here; and yet, with the class of labor we have there, the men who are inured, to wit, the Jamaica negroes, it is held that, for the number of dollars you pay, you are getting just as much labor down there as here. But, sir, it seems to me evident to this committee that the great bulk of this work is to be done by steam power—by steam engines and by electricity—and not by human muscle. These great dredging machines, of course, employ but a small number of men. The crew upon this great dredge you have heard of, built by Mr. Bales, consists of but 17 men, and it will do the work of more than 30,000 or 40,000 men, working with shovels and barrows.

Mr. DOOLITTLE. He said 60,000.

Mr. MILLER. I need not go to the extreme. Coming now to the rock excavation, go to the Chicago Drainage Canal and see the excavating machines, drills, the cantilevers, and the overhead cables for doing all this work. The amount of human muscle to be used is comparatively small at the present day, and it is much smaller than it was when we made our estimates. Now, we are not complaining at the price that this Commission put upon the dredging work, although they raised it a little more than ours; but it is not a material difference. The material difference in the cost they make out on that part of the business comes from the fact that they substantially double the amount of dredging to be done. A canal of the same size as the Suez or Manchester, according to their judgment, is not sufficient for Nicaragua. It must be twice as wide through the river and twice as wide through the lake. They tell us this is done for the passage of the great battle ships which we are now engaged in building.

When the plan of this canal was laid out no such ships were built in the world. This canal is laid out large enough to carry all the war vessels in the world, but the locks would not be wide enough, although wider than any battle ship, but still they would not be wide enough for them to pass. If the Government wants to build it, how much more would it cost to build a lock 10 or 15 feet larger than we have it? It will cost more to build the gates and machinery about it, but it is only a small item. It would not add 5 per cent to the cost of it. In short, then, I have shown you from the best authority there is the cost of unit labor in Nicaragua is not greater than it is in the United States, and I do not need to show you, I simply refer to the fact, that everything else that goes into that canal that belongs to Nicaragua we get without charge, and everything we import we buy in the cheapest market and import without any duties whatever, and, as I have said before, the buildings and all the machinery and everything of that kind will be constructed in this country or Europe and sent down there and put together.

I think I have stated enough about that now, Mr. Chairman. The statement made here yesterday in regard to the cost of unit of labor in

Panama seems to me was most unfortunate. The Commission tells us that they found no time to take soundings upon the San Juan River above the Ochoa Dam, that they had no time, but they did have time at Nicaragua to take soundings upon the canal for 12 or 15 miles, and found it to be only filled in 4 or 5 feet. I do not care about that. Do not let us dispute over small things. Days and days have been used up here in vast amount of stuff which amounts to nothing whatever. There seems to be a great deal of personality in it; why, I do not know. Let those who have indulged in it explain it as they desire.

The figures given forth for the estimated cost of dredging at Panama were most unfortunate. If I am wrong in my memory Colonel Ludlow will correct me. I do not remember any estimate for any of that work at less than 40 or 50 cents a yard for any important part, although there may have been some as low as 20. It seems to me it ran from 50 to 60 cents a yard up to a dollar in the estimates, according to Napoleon Bonaparte Wyse and Colonel Rives, who is in the employ of the Canal Company in the management of the Panama Railroad. Be that as it may be, I presume that these figures were arrived at largely from the prices which were paid by the Panama Canal Company in its heyday, when millions upon millions of money were expended and when it was doing a great amount of work.

Now, what was paid then, and let us see what profits were made. The American Contract and Dredging Company, which plant I bought and brought to Greytown for the purpose of starting upon the work, Mr. Slevin, the man who organized that company, and was the chief manager during all the years it was at work there at Panama, told me the bulk of the work was done for 2 francs per cubic yard for dredging, some of it done for 3 francs, and some of it for more, but that the great bulk was somewhere in the neighborhood of 40 cents per cubic yard for the dredging, and they built these powerful dredgers which we now have, and what was the result? It violates the confidence of no one, because it is well known in New York, and can be known by any one, that the company paid, during the great bulk of the time it was at work, as high as 50 per cent dividends per month. Out of a contract amounting to something over $20,000,000 they divided over $10,000,000 profit on the business, and the Lord only knows, sir, because the Paris courts did not go into it, how much of the other half they paid to the thieves and corruptors in Paris.

Then what are the good of these prices, and are these prices to be brought in here under any kind of authority as a criterion by which the cost of this canal is to be figured upon? It seems to me that it is most unfortunate to bring it in here. It has been shown—as I showed before—we did a large amount of dredging with these machines at an actual cost of 11 cents per cubic yard, and, mind you, we did it under disadvantageous circumstances. The company did not have money enough to push the work, and instead of having two reliefs of men to work the dredges night and day we only worked them ten hours per day, and I need not tell any engineer or contractor to start one of these dredges in the morning takes anywhere from half an hour to an hour, and then you have to stop in the day to get out the water and sand, and so actually of the ten hours they did not operate more than nine hours. If we could have operated the dredges for twenty-four hours per day, using electric lights, we could have done that dredging for at least 15 per cent less than we did, and we would have paid the interest on the investment and everything else connected with it. Undoubtedly a vast amount of the cost of the dredges will be sunk, worn-out, but

when you take the millions upon millions of yards moved and take the cost of purchasing the dredges and divide up the number of millions of yards you will find it is an exceedingly small sum.

Now, then, I stated here the other day that when I went over the line of the canal some four or five years ago, an English engineer by the name of Donaldson went with me. He came as representing the Walker syndicate, which was building the Manchester Canal. He had been the chief engineer of one section on that canal. He spent a month or more at Nicaragua, and he came to New York and went over the plans of the company and all our estimates, and went home to London to make his report. Unfortunately for us and all concerned, Mr. Walker since died, and his estate, I believe, was not sound, and the Barings, who had been interested in the matter and the Manchester Canal, failed, and you all know in regard to that. A few months after that I visited London in connection with an attempt to interest an English syndicate in this matter, and there I saw Mr. Donaldson and he told me he had made his report, but it was confidential and he could not show it to me. He stated if it ever came to light, and I saw it, I would be satisfied with it. I asked him in reference to the estimated cost, and he told me the estimated cost of the canal was a little more than Mr. Menocal's, and there the matter dropped.

I make this statement, sir—it is not necessary, perhaps, to take it up and to say I am prepared to make it on oath—but it appears that Colonel Ludlow thought that the credit of Mr. Donaldson was in some way being abused by the company, and his name was being used to bolster up this matter and he ought to be informed of it, and thus induced to take back whatever he may have said if he said anything; and referring to Mr. Ludlow's testimony we find this letter of the 14th of April, 1896. That has been read; I will not take up your time to read it again, but I submit to this committee that there is not any denial in there of anything I have said, not in the slightest degree. I defy anyone to find it. If it is anything it is simply to throw discredit upon his own estimates. He admits, as he did to me and as I knew, he did not verify Mr. Menocal's estimate of quantities. He could not do that, of course. He took the estimates of quantities as made by our chief engineer and then he got his unit of price for doing the work upon investigation in Nicaragua of what our company was doing when he was there. We were then building that railroad and it was nearly finished.

I do not propose to read that letter. Mr. Donaldson must have had the idea that someone was attempting to use him. I do not know how it has been used. I have never used it in any other way than I am using it now. I have stated it repeatedly to people who have asked if other engineers had looked into the question, and I stated that Mr. Donaldson had, and gave his statement just as I have given it to you now. He says here that Colonel Ludlow has been officially informed as to the use that the company was making of his statement. What that official information means or was I do not know. Whether it means that the Government of the United States, the War Department, had informed him officially of it, or what else it is, I do not know. That is a matter of no consequence, however, but I will not leave it there. As my veracity in regard to this subject has been called in question by Colonel Ludlow, I came here prepared, as I did in the case of Mr. Treat, to prove everything I said.

21 COURTLANDT STREET,
New York, May 1, 1896.

Hon. WARNER MILLER,
Arlington Hotel, Washington, D. C.

MY DEAR SIR: Referring to the question you asked me to-day about Mr. Donaldson, the English engineer, who went with you and Mr. Menocal over the line of the canal, I desire to say:

That in 1894, under the auspices of the reorganization committee, there was an auxiliary committee of the Nicaragua Canal formed in London, of which Sir Arthur Forward, Sir Andrew Clark, Sir Edward Corbin, and others, were members. At a session of that committee Mr. Donaldson appeared and made to the committee, in my presence, a statement as to his knowledge, information, and belief as to the feasibility and cost of the Nicaragua Canal on the lines and plans of Mr. Menocal.

While Mr. Donaldson said that he had not gone over the computations fully, but taking the computations as accurate, under the surveys of Mr. Menocal, he had no doubt in his mind, first, that the line of construction was thoroughly feasible; second, that the canal could be built substantially within the estimate of the company, although, taking in interest and a larger percentage of contingencies, he should fix the total sum for which the canal could be built at £20,000,000.

This statement, as I recollect, was spread out upon the minutes of the committee, and I have sent for copies of those minutes, with which I will furnish you.

My memory, however, is most distinct upon this subject, and I know that Mr. Donaldson stated substantially what I have said in most emphatic terms.

Very truly, yours,

SMITH M. WEED.

Mr. MILLER. Mr. Weed is known to everybody on this committee, and to very many people in this country, for that matter, and I do not believe anybody will undertake to gainsay that statement. So much for that, as I do not care to carry it further. But it is most remarkable that statements made of myself and Mr. Menocal and others should have been called in question by this Commission, for what purpose I do not understand, unless it is to create a prejudice against us throughout the country. Let that stand as it may. I have never troubled myself personally, politically, or otherwise by attacks of that kind, but when it comes in connection with this company and before a committee of Congress, of which I once had the honor to be a member, I like to protect myself with facts, and not with general statements.

Now, let us see what there is in this whole thing and where we are. Concessions were obtained from Nicaragua by a number of gentlemen, and by them a company was organized and they proceeded to raise some $4,000,000 or $5,000,000 and send a corps of engineers to survey the route. It had been surveyed previously by the Government, and Colonel Childs and a large number of men all over the world had investigated it, either as engineers or in the ordinary way of passing over the line. The Congress of the United States concluded, or thought—some of them, at least—that the Government of the United States ought to have this canal and ought to control it and build it, and so they organized a Commission to go down there and investigate all our work and to report upon it as to whether it was feasible and what it would cost, and now what is the result, and what is the difference between the company and the Commission to get at it?

There has been a lot of verbiage and a great deal of personality and talk here which in no way affects this question at all. In the first place, the Commission criticised the entrance to Greytown Harbor, saying it should be moved farther to the east. The answer of the company to that is absolutely perfect. It can not be moved any farther that way, because the Government of Nicaragua will not permit it, because the concession compels us to make it on Nicaragua soil, and when you pass to the point you want to get according to the Commission you go upon the territory of Costa Rica. Colonel Ludlow states they paid no atten-

tion to that, that they knew nothing about that law; they did it purely and simply as engineers, without regard to the concession. Let us pass by that. It is admitted that by building the piers out far enough undoubtedly a channel could be maintained by dredging, and that is the way channels are maintained in all sea canals at their outlet. It was thought that perhaps there should be a slight change of the line across the lagoon. That is of no consequence. We are, however, entirely satisfied that the line proposed by the company is better than the line proposed by them.

When we come to the locks, they say they are possible but ought to be larger in order to admit battle ships. All right; build them larger to take in battle ships or imaginary ships that may be built in fifty years from now. Then we go through the basins, and that is all right. They can be built; there is no doubt about that. They can be built across there with rock and clay and by making proper wasteweirs, etc.; that can be done. When we come to the key of the situation, the Ochoa Dam—I will not take up time in regard to that, as it has been discussed by the hour—but what is the final result? The final result is that the Ochoa Dam can be built, a rock-filled dam, by properly protecting the abutments on the sides so that the water can not get around them, but the Commission think it would be better to build this dam so high the water could not go over it, and turn the water over wasteweirs to be built on the San Carlos.

Now, we do not object to that, and what would have been done when the company came to put a contract for the Ochoa Dam and this canal? Mr. Menocal perfectly understood and everybody in the company understood that we never should have given out any contracts at all until after we had organized a board of consulting engineers of the ablest men we could find in the world, and all of these problems would have been submitted to them, and if they had said it was safe to build this dam and use it as a weir and let the water run over it we should have done so. If they had said it was safer to build it high so that the water should never go over it and make wasteweirs to turn the water out, the decision of the board would have been that that should be done. Of course, Mr. Menocal's estimates were based upon a plan which he believed to be feasible, but Mr. Menocal never asked that the company should undertake a great work like that without submitting it to other engineers. We go to the river and the question is only a question of cleaning out the rapids and dredging the river to a sufficient depth. That can be done. I have bids from responsible people who will do it and at our price.

Now, when you come to the lake, there is mud running out 14 miles. It is a difficult job, undoubtedly, but I do not think the Commission or anybody has any idea or doubt but that it can be done. They may think it will cost more than we do, and they put a price on that of 20 or 30 cents a yard, I do not know which; but I know I can build a dredge, or take one of the modern dredges, and move that mud out of the line of that canal for less than 5 cents a yard. Of course no contractor would agree to do it for that price, because he would not go there and do it for that, but it is being done for less than that. I know the contractors taking mud out of Mobile Harbor are getting 7 cents, and they tell us they are satisfied with their profits. Now, that could be done there.

Then we come to the western side, and what do we find there? It is perfectly even and straight work from the lake down. Nobody doubts that at all. Then we come to the Tola Basin and the Tola Dam. The Commission tells us from the information they have that the Tola Dam

can not be built. Very well, they may be correct and they may not. They have not got sufficient information to determine whether it can be or not. The company have made borings there, and then upon an upper line raised above that, and though we did not get the foundation we wanted, the last work I ordered done upon the canal was, I sent Mr. H. C. Miller and a gang of men with diamond drills to work upon the site of the Tola Dam, and kept them there for several months, and it was not satisfactory; and, while we had not finished when the money of the company gave out, they got a good deal of information.

Why should we stop this great work or hold it for a minute? The company had an alternative, and that was simply to build the canal in excavation right through the basin, the easiest place in the world to take the canal. The object of building the Tola Dam was because of that large basin there, to save excavation, and it was cheaper to build a dam. If it is not safe to build a dam, then abandon it; but I infer from Colonel Ludlow's statement the company never had any such alternative. That was an alternative that was put to me the day I came into the company. I said to Mr. Menocal, "What about this dam; can it be built?" He said, "I think that it can, but we do not know; but if it can not be built we can build it by excavation just as building a canal through any low country."

Mr. Treat went there and told me he would build the dam without any trouble providing the foundation was there; but that we did not know and nobody knew. And then, when you come to the harbor at Brito, there does not seem to be any doubt in the minds of the Commission that can be built. They say it ought to be moved a few thousand or a few hundred feet farther south, for some reason I do not know what; but for that matter it would have been presented to the board of consulting engineers on this work and they would have adopted the plan or not. No great work of this kind, or any great work, like a bridge, the Brooklyn bridge, or the North River bridge, or the East River bridge projected, is built without the plans being submitted to consulting engineers after the company has made its plans; the plans are submitted to the ablest men they can get as consulting engineers, and if they approve it, it goes along just as it is proposed, and if the consulting engineers find that certain changes ought to be made, the company makes them, and that is what would have been done in this case or in any other great work. No man ever knew of a railroad even ten miles long being built without some changes in it after the original survey was made. How about the Pacific Railroad or any great work of this character?

But, Mr. Chairman, this work is to be delayed. Why? Because we have not sufficient evidence to do anything. I submit from a careful examination of this report that the statement that I have just made regarding it that the points of difference between the company and the Commission have been fairly stated, and when fairly stated there is not a ground to stand on why the work should be delayed. They want more data about water. They tell us we do not know how high the water rises. We do know how high it has risen, but we do not know how high it will rise next year. They tell us that the statement I made of the rise of the river being 6 feet is incorrect and that it rises 18 or 20 feet at Machuca Rapids. I gave the average rise through the river, gained from talking with captains living and working on the river for years. If Colonel Ludlow will go with me, I can show him on the Hudson River and Black River where, at the foot of the high falls on Black River, the water rises 25 feet at the foot of the falls, whereas

above the falls it rises only 6 feet, and 2 miles below it rises I think only 8 or 10 feet. Two weeks ago, if you had gone to my mill, I could have shown you 15 feet of water rise at the foot of Palmers Falls, and a mile and a half below the rise is less than 6 feet.

Everybody knows that water piles up at the foot of the falls and where the channel is dammed up it rises there. The moment the dam is built the falls disappear, and instead of a narrow channel that whole river becomes a great lake, whose boundaries are not yet known, as they have not been reached by a survey. By having that much more room for holding the rainfall, the rise would be less rapid and the descent would be less rapid. I understood Colonel Ludlow to say we could not maintain this canal at 110 feet, that because of the waste weirs it would run down. Anybody knows that weirs are built to-day movable, and when a great flood of water comes the weirs are opened and it passes over it, and when there comes a time of low water the weirs are closed and it is held back. The lake can be held at 110 feet, provided there is enough surplus water in the lake to run the canal, and it is estimated it does not take 10 per cent of it. Mr. Chairman, I must take the 4 o'clock train with my family, and I am greatly obliged for your permitting me to come here again to correct these statements made in regard to my former statement.

Thereupon the committee adjourned to meet at 2 p. m. on Wednesday, May 6, 1896.

WEDNESDAY, *May 6, 1896.*

The Committee on Interstate and Foreign Commerce this day met, Hon. William P. Hepburn in the chair.

STATEMENT OF MR. A. G. MENOCAL.

The CHAIRMAN. Mr. Menocal, we will now hear you.

Mr. MENOCAL. Mr. Chairman and members of the committee, I have been directed by the Secretary of the Navy to report to the chairman of the committee, which I have now the honor to do, and I will be very glad to comply with your wishes in any matter you may desire.

The CHAIRMAN. I suppose the order was made for the purpose of giving you an opportunity, if you desire to avail yourself of it, to make any statement to the committee in connection with the subject under inquiry.

Mr. MENOCAL. A great deal has been said before this committee which I have not had an opportunity to read or to hear. I have heard certain statements which have been made here by Colonel Ludlow, however, and upon those statements I would like to make a few remarks, and afterwards, if the members of the committee who have heard the whole of the testimony desire to ask me any questions in regard to Colonel Ludlow's statement, I will be very glad to reply to them to the best of my ability. I stated when I was before the committee but a few days ago that the Nicaragua Canal board had spent two weeks, more or less, in the examination of the line of the canal. When I made this statement, I had in view only the line of the canal as located by the Nicaragua Canal Company, and which I supposed this board had been called upon to examine. I was not considering at the time the whole country of Nicaragua.

You hear frequently travelers who have been through Nicaragua, having landed on the Pacific Coast, traveled across the country and come out at Greytown, tell you they have been over the country and

that the canal route is thoroughly practicable, that they have been all over it, over every foot of the ground, and that there can be no doubt as to its practicability; but it was not that kind of examination I had in mind when I said the board had spent only two weeks, more or less, in the examination of the line. I had in view such an examination as an engineer would have to make of the physical conditions on the spot, so as to be able to ascertain and to weigh the difficulties and facilities that those conditions would present in the construction of such a work as this, and this examination, I know from the nature of the ground, can only be made and this information can only be obtained by going over every foot of the ground.

I said in my statement that two weeks more or less had been spent in the examination of the canal route and its vicinity. When I said its vicinity, I meant such parts of the country as will be more or less affected by the construction of the canal—that is to say, such points along the canal route where embankments were to be built. They are not on the axis of the canal, but nevertheless form a part of the project of the canal itself. Now, I will read for the information of the committee, and in order to vindicate myself as to the statement I made before, a concise synopsis of the movements of the board while in Nicaragua, and then I will leave it to the committee to decide whether I was correct or not in my statement. The board arrived at Nicaragua on the 13th of May, and remained at Greytown until the 21st. They left Greytown on the 21st for the lake and river, taking the steamer at Greytown and going up the river to the lake. They arrived at the lake on the 23d of May, having spent two days in going up the river, of which one day was spent on that portion of the river which is not affected by the construction of the canal.

The 24th was employed by the board in making a trip up the Rio Frio, which empties into the lake, for a distance of perhaps 6 or 10 miles—the exact distance is immaterial—and then they went about 5 miles into the lake and returned to Fort San Carlos. The steamer which was to take the board across the lake was not there, and it was repeatedly stated by the members of the board in my presence and in the presence of those who were around that the time from the evening of the 24th until the evening of the 26th, when the steamer arrived at San Carlos to take them across the lake, was absolutely wasted time; so they were two days there which were declared by the members of the board to be a loss of time to them. They left Fort San Carlos on the evening of the 26th. On the morning of the 27th they arrived at San Jorge, on the west shore of the lake, and the assistants of the board landed there with certain provisions, utensils, etc., and the board continued on their way to the capital, at Managua. They made a visit to Grenada and Managua and returned on the following day, in the evening, to Rivas.

When I was before the committee previously, I had no notes with me. I did not know at the time what was the nature of the investigation to be made by the committee and did not come prepared to answer certain questions which were put to me. I had been seriously ill for ten days, having left my bed to come here, hardly able to stand up; my memory, perhaps, was not quite clear, and as I had no opportunity to correct my notes they were printed containing numerous errors, as I had the honor to report to the chairman of the committee soon after I saw the printed testimony. I said then that the board returned from Grenada to Rivas and spent two or three days in hunting for horses or other means of transportation to go to Brito to commence the exami-

nation of the canal line. That was a mistake. They did not spend two or three days in Rivas at the time; but that is immaterial, because I will show by the records that they were in Rivas five days instead of three.

Mr. DOOLITTLE. During what time?

Mr. MENOCAL. I will let you know. I am going to follow it up, so there will be no misunderstanding about this. My veracity has been questioned, and I want to show the committee what foundation I had for making the statement, and will then leave it to the committee to say whether I was correct or not. They left Rivas on the morning of the following day and arrived near Brito about 4 or 5 o'clock in the afternoon and went into camp. Up to that time nothing had been seen of the canal route. We had crossed the line at one point on horseback and traveled by roads entirely away from the line of the canal to this camping place, and spent the night there. On the following day, in the morning, they started for Brito. They arrived at the harbor of Brito at, I believe, 8 or 9 o'clock, and the examination of the canal route was commenced there.

It is useless to follow the board step by step; but I will say, and if I am mistaken I hope to be corrected right here, that the examination was commenced on the 30th, and that the board returned to Rivas on the evening of the 1st of June, having spent three days between Brito and the lake in the examination of that portion of the canal route. Some portions of the line were not examined. That section running through the proposed basin of Tola was not examined by the board. They traveled by the road on the hills; but that is of no consequence, so I will call that the vicinity of the line, and I count those three days as spent in the examination of the canal route.

The board, as I said, returned to Rivas on the 1st of June, and remained there until the 6th. They started on the evening of the 6th, arriving at Ochoa on the afternoon of the 9th of June. Immediately after arriving there they started to make some examination of the surroundings. On the following day they went up the ridge lines of the proposed basin of the San Carlos, and spent two days there. They came back to camp late in the afternoon of the second day, the 11th, and on the 12th they started on the examination of the route from Ochoa to Greytown. Six days were spent in the examination of that portion of the line from Ochoa to Greytown, arriving at Greytown on the afternoon of the 18th. The board left Greytown for the United States on the 24th.

Mr. DOOLITTLE. The 24th of what month?

Mr. MENOCAL. Of June. Consequently, you will see——

Mr. DOOLITTLE. For the United States or Panama?

Mr. MENOCAL. I mean on their way, practically, to the United States. They touched at Costa Rica and went to Panama, but I understood they were on their way home, touching at other places. I had nothing to do with that, and it is immaterial where they went, and I do not know. Now, if you look over these different dates and add the time spent on the route of the canal you will find they arrived at Nicaragua on the 13th of May, and leaving on the 24th of June the board was forty-one days in the country. Of those forty-one days, fourteen days were spent in Greytown and five days in Rivas. That makes nineteen days; one day visiting the capital makes twenty days; one day traveling from Rivas to Brito to commence the examination of the canal route makes twenty-one; three days traveling over the portions of the country not affected by the construction of the canal makes twenty-

four days, and two days at San Carlos makes twenty-six. If you deduct that from forty-one days I think you find that the board devoted to the examination of the canal line from the Pacific to the Atlantic, or vice versa, as one may call it, fifteen days, including the examination of such portions of the axis of the canal as were gone over, and also the sites of the dams, embankments, etc. That is all I have to say in that regard, and I think my diary is correct in every respect.

There is another question in which my veracity has also been questioned here. It has been stated here that the engineer members of this board were the first engineers who visited a certain portion of this line.

Mr. SHERMAN. The only engineers, it was stated.

Mr. MENOCAL. I am glad you correct me, because I only get this from hearsay, as I have not seen the testimony sufficiently to enable me to pick out from it what is essential and deserves consideration. I have been told that the statement has been made here that this board are the only engineers who have visited some section of the Nicaragua Canal line, that section being between the Danta and Nicholson streams along the line of the embankments of the San Francisco.

I want to say to the committee positively, and I can take oath, if necessary, that I am the first engineer that ever explored that section of the country, and I do not think I will be mistaken when I say I am the first educated white man who went up the San Francisco and Nicholson creeks; I first did so in 1873. I was trying to find a line more or less directly from Ochoa to Greytown. Up to that time all the routes proposed for a canal across Nicaragua had followed closely the bank of the river. I knew the line was a long one, and there were a great many engineering difficulties connected with it, and I was trying to find a path through these ranges of foothills of the San Francisco which would enable me to locate a line more or less direct from Greytown to Ochoa. My first examination, as I said, was in 1873. In 1876 I devoted a number of days again to the exploration of that section of the country. I was very much encouraged by this examination. I had also examined in 1876 the upper portion of the valley of the Deseado from Greytown, which, together with the preliminary examination I had previously made, convinced me that a path existed between those hills through which I could locate a practical line for the building of a canal from Ochoa to Greytown.

In 1885 this matter was brought before the Navy Department, if I remember correctly, by Admiral Ammen, who had followed this scheme from its inception, and he suggested to the Secretary of the Navy that I be sent to Nicaragua to run a line across that country and see if such a canal route could be located there. I was ordered to Nicaragua in charge of a party of engineers to make surveys. I there ran a line from Ochoa to the divide. I had another party running across the divide and from Greytown to the divide. The results of these examinations made by my assistants and myself were such as to demonstrate that the canal route was practical and could be located. Of course, the location then was only a preliminary one, but sufficient to satisfy us that the physical conditions were such as would enable us to locate a canal across that country. I returned to the United States, and this report was published.

Some gentlemen interested in the Nicaragua Canal were very much encouraged by the results obtained by this investigation, and they organized an association, which later obtained a concession from Nicaragua, and at last a company was organized for the construction of the

canal. I was then appointed chief engineer of this company, and we then made a careful and what we call the final location of the route, such as was required in the concession. In making this location, the engineer who was in charge of the location of that portion of the San Francisco Valley, not being thoroughly familiar with the ground, found considerable difficulty in locating the foothills that should form the base of embankments which had been proposed, and while I was engaged in the construction of the gun shops at Washington and other works of the Navy Department the report came from this engineer that they had been unable to locate these hills and establish the practicability of this line of embankment.

Mr. DOOLITTLE. What are those hills?

Mr. MENOCAL. They are the foothills which now form the base of the embankments.

Mr. DOOLITTLE. Between the canal and the river?

Mr. MENOCAL. Between the canal and the river. I went to Secretary Whitney and stated that my reputation, as well as the plan of the canal, depended, in my opinion, upon the solution of this problem then before us. I had been over the country and knew the hills were there, but the vegetation is so dense that you could not see them until directly before you, and these engineers, having never been over the country before, found considerable difficulty in finding the hills upon which we proposed to build the embankments. Secretary Whitney gave me permission to proceed at once to Nicaragua. I obtained leave at 4 o'clock in the afternoon from him, and I started the next day. I arrived at Nicaragua, and I devoted myself to the examination and location of all these hills, and with three parties of engineers started to develop and connect them so as to obtain a chain or line of embankments, with which we proposed to hold the water in this artificial basin.

Mr. DOOLITTLE. I wish you would state about your going up the river at that time, and about what point you stopped.

Mr. MENOCAL. Our headquarters were then at the mouth of the river San Francisco. If you will allow me to point it out, my headquarters were at these islands you see here, and I would take a canoe every morning (there is a gentleman present, who was my secretary, who could testify to that, if it was necessary), and I would go up the San Francisco and then over these hills and spend more or less time upon them to develop them. The statement of the board has been made here upon the authority of a man by the name of F. P. Davis. Mr. F. P. Davis went to Nicaragua for the first time in the latter part of 1887 or early in 1888. Up to that time he had never seen the country. When he arrived at Nicaragua, he was ordered to locate a portion of the divide line which has since been abandoned, and he did not know or see anything of these hills except what he heard from others.

During this time when this report was made that the hills could not be found so as to connect them and obtain the line of embankments which I had proposed, Mr. Peary, of Greenland fame, of whom you very well know, was my assistant, and he withdrew the engineers from the location of what is now called the upper line and put them to work on the location of the lower route on the river bank, and Mr. Davis was transferred from his work on the divide to the location of the line between the Sarapiqui River and the San Juanillo, and he was engaged there for some time, and on the completion of this service he was discharged, work was suspended in Nicaragua, and he returned to the United States. In the meantime this chain of hills to which I have

referred, and which it has been stated to this committee I never saw, had been thoroughly examined by three parties of engineers. The chain of canal embankment was laid down practically as it is to-day, with some slight modifications made after more complete investigations with the cross section of every hill and every valley, and it is practically the same as it was located in 1888 when I was there, and any engineer can see that. That is all I think that is necessary for me to say in connection with that matter.

Now, there are a great many questions which have been raised here affecting more or less my ability as an engineer, and even my veracity, and I can not refer to them now, because I have not seen the testimony, and part of my information of the testimony is hearsay; but I suppose the members of the committee, who are thoroughly familiar with the subject, will be good enough to ask questions on any points which they may think essential, and I will be glad to reply to the best of my ability. Later on, when this voluminous testimony is printed, if I find in it anything essential that really needs consideration or reply, I will take pains to do so. In the meantime I refer the committee to my original statement, which has been printed in that testimony, and I will be willing to stand by it. I have not a word to add or a word to take back. Mr. Chairman, I really do not know whether I should proceed on other matters, which I do not regard as very essential. Perhaps the members of the committee may want to ask some questions, and I will be glad to reply to them.

The CHAIRMAN. Mr. Menocal, I would like to ask you a question. You sent to me a copy of the testimony delivered here at a hearing, with certain amendments or corrections?

Mr. MENOCAL. Yes, sir.

Mr. PATTERSON. Be seated, sir.

Mr. MENOCAL. Thank you.

The CHAIRMAN. Those corrections are made with a pen and ink, except one?

Mr. MENOCAL. Yes, sir.

The CHAIRMAN. On page 57 where you strike out the figure 3 and insert the figure 2 in pencil—when did you make that last correction? It is in answer to a question by Mr. Bennett: "At what do you estimate the cost of the Ochoa Dam?"

Mr. MENOCAL. Well, sir, I have not had that document in my hand since. I will speak to the committee for a moment, and perhaps my explanation——

The CHAIRMAN. I call your attention to it, and you see this correction is in pencil and all the others are in ink.

The CLERK. The clerk will say that a gentleman called and asked for that copy and said——

Mr. MENOCAL. What gentleman?

The CLERK. And said that Mr. Menocal authorized him to make the correction. I do not see him here now.

Mr. MENOCAL. I have not made that correction, but I will explain that. It is immaterial and I will give my reasons for saying it is so.

The CHAIRMAN. Who made that correction? What authority had that gentleman to make a correction in the stenographic records of this committee?

Mr. KERN (the gentleman referred to). When Mr. Menocal explains to you——

The CHAIRMAN. I want to know from you what authority you had to tamper with the stenographic records of this committee?

Mr. KERN. Well, Mr. Chairman, I did not consider I was tampering with the records, and I did not do it without speaking to the clerk of the committee. I simply in conversation mentioned the matter and I understood Mr. Menocal said that he——

The CHAIRMAN. Who authorized you, sir, to make that change?

Mr. KERN. I think Mr. Menocal's statement will clear that up.

The CHAIRMAN. I am asking you the question, sir?

Mr. KERN. Mr. Menocal; I spoke to him about it.

The CHAIRMAN. How did it interest you, if you please?

Mr. DOOLITTLE. There is this to be said about it.

The CHAIRMAN. I want that gentleman to make an explanation. I am the custodian of this paper.

Mr. DOOLITTLE. I am not seeking to make any explanation. I want to say this, however, that this gentleman, as Mr. Menocal has stated, was with him in Nicaragua and was here at the time the written statement was submitted to this committee, and is a gentleman I have known right well since I have been here, and so far as I am concerned and from my knowledge of him, I feel satisfied in whatever he did he supposed he was following a proper course.

The CHAIRMAN. Will you not let him say what he did first, instead of making apologies and explanations?

Mr. DOOLITTLE. I am not desiring to do that. The only thing I am desirous to do is to rather relieve what under the circumstances would be a very embarrassing situation, which he says Mr. Menocal's statement will clear up, and that is all I have to suggest. Of course I do not want to——

The CHAIRMAN. I think I understand something about the situation myself. The matter becomes important, as the committee will remember, because a criticism was made by one of the gentlemen of the Commission referring to that change in the estimate, and now, as I have said, I wanted to know who had done it.

Mr. KERN. I would like to say this, if you will permit me, Mr. Chairman, that the attention of the clerk was called to the fact that there was a change made, and it was not made in a surreptitious way. It was simply made with his knowledge——

The CHAIRMAN. You did not call my attention to it?

Mr. KERN. I thought it would be called to your attention. I thought it was well known it would be called to your attention by the clerk of the committee.

The CLERK. I supposed that Mr. Menocal had authorized him to make it.

Mr. MENOCAL. I could not say I authorized it. When I arrived here two or three days ago, I met Mr. Kern, and he spoke of numerous errors contained in the printed testimony. I told him there were a great many errors.

The CHAIRMAN. What do you mean by errors?

Mr. MENOCAL. I mean——

The CHAIRMAN. Do you mean grammatical errors?

Mr. MENOCAL. Yes; and in figures, quantities, the draft of a ship being referred to as 40 feet, reducing the sharpest curvature of the river to 3 feet, which are absurd errors, as anybody can see. There are other errors.

The CHAIRMAN. But you had read this subsequent to its publication and you had not made that correction.

Mr. MENOCAL. No, sir; I am going to come to that and tell you how it was made. I arrived here and I met Mr. Kern and he told me he had

seen numerous errors in the printed testimony, and I said I had corrected one of the printed copies in great haste and sent it to the chairman of the committee, correcting only those things which anybody could see were material errors, and I saw one in which the question being asked as to what would be the probable cost of the Ochoa Dam and I had stated $3,000,000. I did not attach much importance to it, as I was in great haste, and I sent it to you with a letter asking to have those errors corrected. I might have left in the 3-foot curvature of the river, but anybody could see it was a mistake. It is an error, misprint, or something. Nobody would take advantage of that, but when I was asked what would be the cost of the Ochoa Dam, I had no notes at hand, and, ill as I was, I repeated from memory what I thought at the time was more or less so.

I had not seen these documents for a long time, except for a few days, perhaps a week or so, after I returned from Nicaragua, and I had not even looked at the estimates. I had other matters to attend to, and have not paid much attention to the Nicaragua Canal for some time, and I said that the section from Ochoa to Greytown will cost so much, etc., speaking from memory, and when I was asked what the Ochoa Dam would cost, I may have said inside of $3,000,000, but I believe, however, I said $2,000,000, as I could not remember the amount. I knew it was in the vicinity of a million—$1,200,000 or $1,900,000, or something of that kind—and in order not to estimate too low, so as not to make it appear that I desired to magnify the great benefits to be derived from the construction of the canal by the method I had proposed, I think I put the round figures at $2,000,000, which is little enough, and when I met Mr. Kern here I said that there was an error I had overlooked when I corrected the printed testimony.

I did not correct that error, for the reason it was immaterial. The board had just published the last estimate I made, which shows my estimate of that dam to be less than a million dollars, and consequently there was no reason why I should come here before the committee and say it was $3,000,000 when the committee or anybody could verify it. It could not be expected that I should be absolutely exact, as they understood I was talking from memory, hastily, and in ill health. I met Mr. Kern, and told him I had not corrected it, and that advantage had been taken of that error; and I think Mr. Kern said there was time yet to correct it. Perhaps I told him I should be very glad if he did so. I do not remember the conversation, but that is the way it came about. I have not had the paper in my hands, and have not read the correction myself.

Now, with the permission of the committee, I will refer to another matter which has been brought before you here. It has been stated that there is an error of a foot in the level of the canal from Greytown to Ochoa, and that one of my assistants by the name of Bennett was engaged in correcting those levels when the work was suspended in Nicaragua. Such a statement is incorrect, and there is no foundation for it. Mr. Bennett's last year's work in Nicaragua was to make new cross sections of the sites of all dams and embankments, and when that work was completed, he was discharged and left for the United States. I knew that was a fact from memory, but, to be sure, I telegraphed him and asked what had been his last work in Nicaragua, and he has replied saying it was, just as I remembered, the relocation of the sites of dams and lines of embankments.

If there is an error in the levels of the canal in Nicaragua, I know absolutely nothing about it, and whoever made the statement must have

done so for a purpose; and if the statement has been made by this engineer, Mr. Davis, who has been mentioned in this investigation, he violated the trust I had placed in him, because he never reported it to me, and he was responsible for the correctness of all surveys and all levels made there for the last two and one-half years, when he was my first assistant; and as to Mr. Bennett being connected with the checking of these levels, the statement is incorrect and has no foundation at all.

Many questions have been raised here about engineering points too numerous for me to remember now. I will at the proper time bring them up if I have an opportunity, but as I have said before, I am perfectly willing to stand by the written statement I have submitted to the committee. I have not one word to take back or to add to it.

Mr. DOOLITTLE. That is, not your verbal statement to the committee but the manuscript statement?

Mr. MENOCAL. The manuscript statement which I have submitted. There seems to be a misunderstanding in one or two points which I would like to bring before the committee. It has been stated that the proposition of keeping the lake at 110 feet above sea level with a fluctuation of a foot and a half above or below that level as I have stated in the written statement is something novel. Well, Mr. Chairman, I will leave that question for engineers to decide. We are not discussing here all the elements of the problem, but I will say this, that I do not believe that there is an engineer in the world who believes for a moment that when I said the level of Lake Nicaragua was to be maintained at 110 feet that I meant that this level should be fixed and invariable.

Mr. Chairman, you can not control it. It is a large lake in a country where there is a tremendous rainfall. You can not take the water out of the lake, or draw it out as fast as it accumulates by the rains and discharge of the rivers flowing into it. It is bound to rise in the rainy season until it attains the required hydraulic head to increase the flow sufficiently to carry off the surplus water, and it has to fall in the dry season because there is little or no water flowing into the lake while you are drawing from it for the operations of the canal and to provide for evaporation, etc. This immense lake is not a tub with a faucet attached to it by which you can control it at will so that it does not fill up, or that you can fill up and keep at the desired level. It is impossible to do so. During the rainy season the water accumulates in the lake and gradually runs off by reason of the increased head, and in the dry season, when little or no water flows into it, the level necessarily falls. I did not go into these small particulars in my report because I did not regard it as necessary.

The CHAIRMAN. Mr. Menocal, right there—is it not essential to the completeness of your enterprise that you should maintain it at 110 feet as a minimum?

Mr. MENOCAL. Not necessarily. I could change my enterprise and make it 106 feet, or make it 108 feet, or 112 feet; that is entirely immaterial. If it was not because of flooding valuable lands in Nicaragua I would make that lake high enough so that there would be no necessity of dredging on the river San Juan, and it is a question yet as to whether it would not be more economical to buy such private lands as may be flooded by raising the lake 4 or 5 feet more than to pay for the necessary excavation in the river. Mr. Chairman, you can adopt any level you choose, provided that the depth of your channel in the river and lake is sufficiently deep, so that when the lake falls to what you regard to be the minimum level there will yet be depth of

water enough in the channel to float such ships as you propose to carry through the canal.

The CHAIRMAN. My query was based upon the supposition that you expected to have your 28 or 30 feet, or whatever it is, through the river and through the channel, which you dredge in the lake on the supposition that you maintain it at 110 feet?

Mr. MENOCAL. That is treated——

The CHAIRMAN. Suppose that that is your plan, then will it not be necessary for you to maintain the level at 110 feet?

Mr. MENOCAL. No, sir; that is all treated in that printed testimony you have before you; that question is gone over fully. If the channel we have proposed in the river is temporarily 28 feet, and the lake can be controlled within 2 feet, which I am confident can be done, it may be allowed to rise to 111 feet and to fall to 109 feet; or if the fluctuation is as much as 3 feet, the maximum and minimum levels would be 111½ to 108½. What would be the result? If we have a channel at the start of 28 feet depth and the lake falls to the minimum level, we will still have 26½ feet in the river. When it rises we will have more than is needed, and when it falls to the minimum we have still 26½ feet of water—just the same, or nearly as much, as any canal in the world to-day—and I contend that the fluctuation is inevitable; it is a necessary condition, and you can not build a canal there without it.

Mr. DOOLITTLE. You speak of 26½ feet as being as deep as any other canal. Has not the Suez been recently dredged and deepened——

Mr. MENOCAL. Not to my knowledge, but it may be. The Manchester Canal and the Kiel Canal, which are the latest that have been designed and built, so far as I know, have that depth. I was upon the Manchester Canal during its construction, visiting it frequently during the last two years, in close relations with the engineers and contractors, and spent days over it, and I have a table here showing the depth of the different canals of the world. Would you like to see it?

Mr. DOOLITTLE. If you please. What do you read from?

Mr. MENOCAL. I am reading from a paper that I prepared on the Nicaragua Canal in 1893, and these figures are from official documents. Now, I will give you the depths of the various canals. The original dimenions of the Suez Canal was 26.2 feet in depth, and the larger dimensions which are now being carried out will be only to 27.9 feet. The Manchester Canal is 26 feet in depth. The Amsterdam Canal is 23 feet, the Corinth Canal is 28 feet, the canal proposed at Panama is 27.8 feet, and the Kiel Canal is 28 feet in depth.

Mr. BENNETT. Will the Kiel Canal admit a vessel drawing 28 feet of water?

Mr. MENOCAL. No, sir. There are few vessels in the world drawing 28 feet. There are few battle ships drawing much over 25 feet.

Mr. BENNETT. How much do battle ships draw?

Mr. MENOCAL. I should say 25 feet, the largest. The *Indiana*, now in New York, draws 25.3.

Mr. PATTERSON. One question in that connection. Are your locks so planned as to make the canal navigable for battle ships?

Mr. MENOCAL. These locks were originally designed at a time when battle ships had not been built or even designed as large as they are now, but they were made wide enough to accommodate the commerce of the world; they were made 70 feet wide. Battle ships have been built since with a larger beam, and in order to pass them through the canal the locks would have to be increased in width about 10 feet. That is, however, a small matter, as it only requires a little more width

of foundations and larger gates. That is all. The question as to whether the locks should be built 70 feet wide or 80 feet wide has been considered by the company, and I am free to say that the company has decided that if the canal is built under its control the width of the locks shall be 80 feet. Is there anything else the committee would like to ask?

Mr. JOY. What is the beam of the largest battle ship now?

Mr. MENOCAL. If I am not mistaken, it is 73 feet. Is not that so, Mr. Endicott?

Mr. ENDICOTT. It is 72.3.

Mr. MENOCAL. I knew it was in the neighborhood of 73 feet. Of course, there was no necessity when the locks were designed to have them larger than 70 feet, and if the canal is to be built for commercial purposes only even now no company will undertake to spend several millions of dollars to make a canal large enough to accommodate a few ships which may never pass through the canal. In the meantime, the company would lose the interest on the money invested and the amount of tolls paid by such ships passing through the canal would not justify the company in spending a large additional sum of money necessary to make the canal large enough to pass them. This canal was designed for commercial purposes and evidently is of sufficient dimensions to pass all the commerce that will seek it.

Mr. PATTERSON. That is true, but at the same time if the Nicaragua Canal was constructed it would be a very essential part of our coast defense.

Mr. MENOCAL. No doubt, sir. I say when we were designing this canal these battle ships had not been built. It was designed large enough to take in all the war ships that had been built up to that time. Since then these new ships have come into existence, but, of course, I would be very glad to see the width of the locks increased so as to enable them to pass through it.

Mr. DOOLITTLE. And if it were built as a Government enterprise——

Mr. MENOCAL. If it were built as a Government enterprise of course the Government could afford to spend several millions of dollars especially for that purpose, because I have such opinion of the importance of this canal to the Government that I think the Government would be justified in building it if it was only as a military canal, independent of its great importance to the commerce of the United States.

Mr. PATTERSON. I was very much impressed with Colonel Ludlow's statement in regard to the bottom of the San Juan River at Ochoa. Now, have you made use fully of soundings and borings there?

Mr. MENOCAL. I refer you again to that written statement. This matter of the plans of the company has been somewhat misunderstood, due probably to the manner in which the subject has come before the committee. The company was organized and engineers were sent to Nicaragua with instructions to make the final location of this canal so as to complete the plans and file them with the Government of Nicaragua within eighteen months—I think that is the length of time—after the date of the concession. The location was made with all dispatch, six or seven parties of engineers being distributed along the whole line. Of course borings could not be taken until the line was located. There were certain sections of the route which we knew could not be changed very much after the preliminary surveys were made, and as soon as the topographic condition was developed boring parties followed the engineers; but in other sections of the country borings were not made, and could not be made, until the final location was completed.

Then, in eighteen months or less, these plans were made from the data obtained by the original surveys and the plans completed sufficiently in detail to be submitted to the Government of Nicaragua for its approval, and they were approved; but they were deficient in a great many respects. No borings had yet been taken at the site of Ochoa Dam, and no borings with the diamond drill had been taken at the deep cuts or at the site of the Tola Dam. West of the lake there were only a few borings made with an auger, such as were able to be made in that short length of time, for the reason, as I have stated, that the line was not yet finally located. When this preliminary examination and plans were made, the estimated cost was made, based on surface indications. At Ochoa there is a hill on which rocks crop out at the south abutment of the proposed dam. There is an island a little below it, which in the dry season shows gravel all around as far as can be seen. The abutting hills are clay; you can see that.

Mr. PATTERSON. That is on the north side?

Mr. MENOCAL. On both sides; clay with bowlders projecting out here and there, especially so on the south side. Well, we had to make an estimate as near an approximation as could be made with the information available, and were guided by surface indications and by a few auger borings which had been made up to that date. The plans thus made were submitted to the Government of Nicaragua for approval. Pending the approval of the plans, a period of probably six months or so, the engineers were retained in Nicaragua making additional surveys and borings. Mr. Francis Le Baron was in charge of these engineers. In October, 1889, the company having obtained the necessary funds to commence work of construction, to complete the final surveys, and to make the necessary borings, we purchased diamond drills, organized another large corps of engineers, and returned to Nicaragua; and the whole line was relocated in detail.

The line of the eastern divide cut was shifted from the line originally located by Engineer Davis to another line, which I had found in 1885, and which I thought was the best; but when I sent my assistant there to make the location in 1889, he started on another line, which had also been examined by me in 1885. I had given orders to survey both routes, but only one was located for lack of time, and, as I have stated, that was changed later on. The line of embankments was more carefully located to better conform to the topography of the country, and borings were continued on the whole line to the bottom of the canal on both sides and at the Ochoa Dam. At Ochoa Dam we have taken borings enough to satisfy us that the hills are clay, with bowlders, and the river bottom sand as far as we have gone.

The CHAIRMAN. May I ask you there what was the depth of these borings?

Mr. MENOCAL. In the river?

The CHAIRMAN. At Ochoa Dam; yes, sir.

Mr. MENOCAL. On the abutting hills some of them (I am speaking from memory, I have no documents here) were 50 feet and some 60 feet deep, and I think, if I am not in error, one or two went as deep as 70 feet, and we found nothing but clay.

The CHAIRMAN. And on the bottom of the river, what was the depth of the borings there?

Mr. MENOCAL. From 24 to 26 feet, probably 28 feet, sufficiently to satisfy me that rock did not lie at a depth that would make the construction of a stone masonry dam at that point practicable. Rock may be found there if you go deep enough, but if such a dam was built of

concrete or stone it would be extremely expensive and very difficult to build.

The CHAIRMAN. Were these borings made with the diamond drill?

Mr. MENOCAL. No, sir.

The CHAIRMAN. They were made with an auger?

Mr. MENOCAL. Yes, sir.

The CHAIRMAN. Did that reach rock?

Mr. MENOCAL. We did in places reach rock which I think were bowlders. I do not think we struck a rock ledge in any place. Based on that information, I came to the conclusion a stone dam there was not practicable.

Mr. DOOLITTLE. Masonry, you mean?

Mr. MENOCAL. A masonry dam.

Mr. PATTERSON. You found no rock on the bottom of the river—it was all sand?

Mr. MENOCAL. All sand; of such a depth, as I stated before, as to make the construction of a masonry dam, if not impracticable, extremely expensive.

Mr. NOONAN. I understood you to say you found rock there with the clay?

Mr. MENOCAL. I beg your pardon; I will come to that later. The abutting hills are clay and the bed of the river is sand.

Mr. NOONAN. What is the character of the sand—quicksand?

Mr. MENOCAL. No, sir; coarse river silt and sand, such as you find in the alluvial section of the San Juan.

Mr. PATTERSON. My attention has been called to this sentence in your report of 1893: "At the site of the Ochoa Dam, gravel, clay, and rock, in the order named, are shown by the borings."

Mr. MENOCAL. Is that the report of 1893?

Mr. PATTERSON. Yes, sir; 1893.

Mr. DOOLITTLE. Was that the Chicago report?

Mr. MENOCAL. I would like to see what paper it is and on what page. Where is that?

Mr. PATTERSON. It is right there; I will show it to you [pointing out on page of pamphlet].

Mr. MENOCAL. Yes, sir; I see the statement. I will explain that now. When the original report and plans were made, as I stated to the committee a moment ago, we were guided by surface indications only. We saw there that the hills were clay with indications of rock at some depth, since rock was cropping out on the south side, and gravel was found on the banks of the river at low water, and the report was framed to conform to those conditions. In 1890, after we made the borings, the estimates were corrected all along the line, so as to adjust the amount of work both in quantity and quality to the results obtained by the borings, and those quantities stand to-day. When these changes were made, the estimates of 1889, which were based on surface indications, were corrected, and I stated at the foot of it, I think, "Corrected up to January 1, 1890." I see now that when I prepared this paper I must have copied that sentence from the original report of 1889, or for some reason the statement was probably transferred from the old document; but, Mr. Patterson, permit me to ask, are we to pick flaws here of this kind when we have presented to this board——

Mr. PATTERSON. Not at all.

Mr. MENOCAL. When the results of the borings are given to the world? Have we not given to this board all the information we have?

Have we not shown the borings taken in the bed of the river, showing sand there and clay in the abutments? Why should you pick flaws here from a paper I wrote in great haste, to be read at a convention? I admit it is a misstatement; but have we not presented the board with all the data on which our claims are based?

Mr. PATTERSON. Now, I want to say this to you. I called your attention to that simply for the reason it was commented on here.

Mr. MENOCAL. I know, sir, it has been brought before the committee.

Mr. PATTERSON. And what I wanted to do was to get at the real facts.

Mr. MENOCAL. Those are the real facts.

Mr. PATTERSON. If it be true, as stated in that paper, that the first thing you struck at the bottom of the San Juan River is sand and then clay and then rock——

Mr. MENOCAL. No, sir.

Mr. PATTERSON. I meant to say that if that be the fact it would go a long way toward satisfying my judgment upon a very difficult problem, and I think the most difficult problem—now, I am no engineer—connected with the Nicaragua Canal, and if there is anything about this Nicaragua Canal scheme now that remains undemonstrated in my mind, in my humble judgment, it is the practicability of constructing the Ochoa Dam so as to retain your summit level. If rock can be found at the bottom of the river, I think it would be very well and I was anxious to find out.

Mr. MENOCAL. I have no assurances——

Mr. STEWART. Was there a dispute about that?

Mr. PATTERSON. No, sir.

Mr. MENOCAL. Permit me to complete what I was going to say. I have no assurances there is no rock at a certain depth. Rock may be found 40 or 50 feet deep in the river bed, and I have only gone down 24 or 25 feet; but enough to satisfy me that for practical purposes of construction we have nothing but sand there. Now, that being the case, we had to devise a method of construction that was applicable to that particular site and would meet those particular conditions. This rock-filled dam was then proposed by me, and has since received the approval, I think, of all the engineers who have studied the subject, and this board has arrived at the same conclusion—that it is practicable with slight modifications in the method of construction, which are matters of detail; but the dam is admitted to be practicable. Whether you are going to spend $500,000 in strengthening the abutments, or $100,000 or $50,000 is only a matter of detail, and other changes proposed, such as having a set of sluices to discharge the river during construction, which I think will be a bad scheme, and is only a modification of construction methods not affecting the practicability of the work. The dam can be built. They state it can be built.

We have been told here that when this board returned from Nicaragua it was all obscure; they could not see how this canal could be built; they were full of doubts, and did not believe it could be done. However, after they met in New York and looked over the date furnished by the company, and consulted and talked the matter over, they came to the conclusion that the canal is feasible and absolutely practicable, as has been stated before this committee. By what means did they arrive at these conclusions? Not from the investigations they made in Nicaragua, since they left the country with the opinion that the canal was impracticable. Why, it was from information we gave them.

Mr. CORLISS. I would like to ask you, under the concession how many more years were allowed for the construction and completion of the canal?

Mr. MENOCAL. The concession as it stands now will expire by limitation in October, 1899.

Mr. CORLISS. Is there any provision for extension?

Mr. MENOCAL. There is a provision for extension; that is, if on account of insurmountable difficulties, of calamities such as earthquakes and conditions of that kind, the company should not complete the construction of the canal in ten years, the Government of Nicaragua binds itself to give an extension of time, which is not named in length. That provision you will find in the concession.

Mr. JOY. Let me see if I understand you. The concession, as it now exists, is for the completion of the canal by 1899?

Mr. MENOCAL. The company had ten years to build the canal from the time the work was inaugurated. The work was commenced October, 1889, and consequently the time at which the concession will expire by limitation is in October, 1899; but there is a provision in the concession, as I have stated, by which the Government of Nicaragua binds itself to give an extension of time in case of unforeseen circumstances, calamities, etc., which the company could not avoid. Now the question to be settled is whether the financial troubles the world is going through and other difficulties that have occurred since the work was commenced are not sufficient to justify the company in asking for this extension and the Government of Nicaragua in granting it.

Mr. CORLISS. One other question: In your judgment, can the canal be completed within that period?

Mr. MENOCAL. No, sir; not by 1899. I think the canal can be built in between five and six years, if the money is available as fast as it is needed, and the work properly conducted. I think it can be completed inside of that time.

The CHAIRMAN. Under the concession, what was the company to do in the way of expenditures the first year?

Mr. MENOCAL. The company was to spend $2,000,000.

The CHAIRMAN. When was the expiration of that period?

Mr. MENOCAL. It was October, 1890.

The CHAIRMAN. Did you represent the company in establishing the fact to the Nicaraguan Government that the expenditure had been made?

Mr. MENOCAL. Yes, sir; I did, in this respect. I was representing the company in Nicaragua, and the Government of Nicaragua appointed two or three commissioners—I think three—who came to Greytown, where I had my headquarters, with instructions from the Government of Nicaragua to examine the cost of the work which had been done by the company and inform the Government as to how much had been spent up to the 10th of October, or sometime in the month of October, on the works of the canal. The investigation was made, and I gave them all the information I had, and our books were open to them. They saw what we had done and what we were doing, and they reported that the expenditures up to that date—I am speaking now from memory—were about three millions and some hundreds of thousands of dollars.

The CHAIRMAN. Did you include in that the plant which had been procured as well as the work which had been done?

Mr. MENOCAL. Yes, sir; the plant which had been procured, and also the cost of the Navigation Company, which had been purchased by the Nicaragua Canal Company because the owner of the Navigation Com-

pany had the privilege of navigating the river and lake, and one of the provisions of the concession was that the company could only obtain this privilege and have the right of navigating the lake and river by some arrangement with this individual, and he set up his price at $300,000 for his boats, his grant, storehouses, and everything else, and the company had at last to pay it.

The CHAIRMAN. What company bought that; was it the Construction Company or the Maritime Canal Company?

Mr. MENOCAL. You are asking me in regard to matters to which I paid very little attention.

The CHAIRMAN. Well, I will ask that in a different way. In establishing the fact that the expenditure of $2,000,000 had been made, did you include in that whatever sum, $300,000 or $100,000, which was paid by the Construction Company?

Mr. MENOCAL. Yes, sir.

The CHAIRMAN. That was an asset which belonged to the Construction Company, was it not, and not to the Maritime Company?

Mr. MENOCAL. That is a point that I am not prepared to answer. My impression of that arrangement was this: The Construction Company paid for everything, and at the end of a certain time, call it a month or say six months, a bill was presented to the Maritime Company for the value of the work done or the expenditures made, and the Maritine Company would then pay for these expenditures by some arrangement—in securities, bonds, stocks, etc. Consequently, from the moment the securities were turned over to the Construction Company the plant and whatever work had been done and paid for became the property of the Maritime Canal Company. Have I expressed myself clearly?

The CHAIRMAN. Yes, sir. Now, do you understand that the Maritime Company is the owner of that franchise?

Mr. MENOCAL. Yes, sir.

The CHAIRMAN. For the navigation of the river?

Mr. MENOCAL. That is my understanding.

The CHAIRMAN. Did you not state, when you were before this committee during the last Congress, that the franchise was owned by the Construction Company?

Mr. MENOCAL. Well, I have explained now that the Construction Company bought all the plant and paid for and did all the work; but by some arrangement which the Construction Company had with the Maritime Company, the Construction Company was at some time, which I could not tell you—as I said before, I had nothing to do with the financial affairs of the company and I do not know that I have the right to say here what I am saying—but I know that some arrangement of that kind was made by which the Maritime Company paid the Construction Company the expenditures made for the construction of the canal everything pertaining to the canal, and these payments were made, I think, by securities. Now, what the proportion was I can not say.

The CHAIRMAN. What do you mean by securities; bonds or stocks?

Mr. MENOCAL. As I say, I mean bonds and stock.

The CHAIRMAN. In what proportion?

Mr. MENOCAL. That is just what I say I do not know.

The CHAIRMAN. Did not you negotiate this transaction?

Mr. MENOCAL. No, sir; I had absolutely nothing to do with the financial arrangements of the company.

The CHAIRMAN. Did not you negotiate for the purchase of this franchise?

Mr. MENOCAL. Yes; if you refer——

The CHAIRMAN. Do you not know the terms of payment?

Mr. MENOCAL. If you refer to the franchise the company obtained from Nicaragua, I negotiated that.

The CHAIRMAN. I do not mean that, but I mean the franchise right to navigate the San Juan and the lake?

Mr. MENOCAL. No, sir; I had absolutely nothing to do with that, and I never even negotiated for a barrel of cement for the company.

The CHAIRMAN. In establishing the fact to the satisfaction of the committee appointed by the Government of Nicaragua that $2,000,000 had been expended by the company, did you include the purchase for about $775,000 of a certain dredging plant, etc., which was bought at Colon?

Mr. MENOCAL. I remember distinctly that a portion of that dredging plant was included; whether it was all or only part of it I can not say, as I do not remember. It is a long time ago, but I think that a portion of that plant and the cost of its transportation to Greytown was a part of the expenses which were included in making up that amount.

The CHAIRMAN. Now, will you state which company purchased that plant?

Mr. MENOCAL. No, sir; I could not tell you.

The CHAIRMAN. Was it the Construction Company or the Maritime Company?

Mr. MENOCAL. I have to beg your pardon, as I do not know anything about it. There are others better informed on that subject than I am—Mr. Miller, who was then president of the company; and there is the secretary of the company, and others. I had nothing to do with it.

The CHAIRMAN. In establishing the fact that there was an expenditure of $2,000,000 made during the year did you include an item of $105,000, or about that, for a dredge purchased in Glasgow?

Mr. MENOCAL. There may have been. I do not remember the item now.

The CHAIRMAN. Were you a party to the report that was made to the Nicaraguan Government as to these expenditures?

Mr. MENOCAL. No, sir.

The CHAIRMAN. You did not sign the report?

Mr. MENOCAL. No, sir. I have no copy of the report with me, and I only remember the circumstance that these commissioners came there and the books were open to them.

The CHAIRMAN. Do you remember the names of those commissioners?

Mr. MENOCAL. I remember two of them. One of them was Mr. José Antonio Roman and the other was Maximilian Sonnerstern.

The CHAIRMAN. Have you ever seen the report made by either one of those gentlemen to the Nicaraguan Government?

Mr. MENOCAL. No, sir; I have not.

The CHAIRMAN. So that no report made by them was in any way verified by your signature?

Mr. MENOCAL. No, sir; I had nothing to do with the report. I only gave the items, and the books were open to them and they got the data from them.

The CHAIRMAN. If there was an item of about $105,000 for a dredge purchased in Glasgow included in those amounts, can you state whether or not that dredge was ever received at Greytown?

Mr. MENOCAL. I have an impression—in fact, I know—the company did buy a dredge in Glasgow, and that this dredge never reached Nicaragua.

The CHAIRMAN. It was sent to Australia, was it not?

Mr. MENOCAL. I do not know, sir. I know a dredge was purchased in Glasgow, and that this dredge, the first one built, was sunk on the coast of England, but whether it was sunk on its way from Glasgow to Greytown, or to Australia, I do not know, as I had nothing to do with it; but I know the dredge was sunk at sea.

The CHAIRMAN. Was it not sunk at sea off the English coast on its way to Australia?

Mr. MENOCAL. I do not know. I have no idea. I know it was sunk; I know that fact; at least I have been told so. I know it as you would know from hearing me tell you. I know another one was ordered or purchased——

The CHAIRMAN. Was it ever received?

Mr. MENOCAL. It was ordered, and I understand it was sold afterwards without having been sent to Nicaragua, because the work had stopped before the dredge was brought over.

The CHAIRMAN. You are not able to say whether that item of expenditure was included in the $2,000,000 of their alleged expenditure made during the first year?

Mr. MENOCAL. No, sir; I could not make any statement in regard to that.

The CHAIRMAN. Do you remember at what the work—when I speak of work I mean excavations in the canal or excavations in the harbor—what was the estimate of that Commission?

Mr. MENOCAL. No, sir; I do not.

The CHAIRMAN. Did you furnish the Commission with any amounts or sums representing this class of work which had been done?

Mr. MENOCAL. Mr. Chairman, the Commission, if I remember correctly, did not estimate the value of the work. They took the expenditures which had been actually made. The terms of the concession were that the Canal Company had to actually expend $2,000,000 in the first year, and the commission for Nicaragua had nothing to do with the actual value of the work which had been performed.

The CHAIRMAN. Now, it was your mission there, as a representative of the Canal Company, to show to those gentlemen what expenditures had been made?

Mr. MENOCAL. Yes, sir.

The CHAIRMAN. And you represented the company in doing that?

Mr. MENOCAL. I did.

The CHAIRMAN. Now, what amount did you represent to them had been expended for this class of work of which I have spoken?

Mr. MENOCAL. Mr. Chairman, I did not keep those documents. What I did there was to open to these gentlemen the books which were kept in Greytown, and to give them certain memoranda which was sent from New York—extracts from the books in New York, I suppose. That is all I did in connection with it.

The CHAIRMAN. When you represented to them that expenditures had been made did you explain to them whether those were cash expenditures, or expenditures of securities, bonds, or stocks?

Mr. MENOCAL. I gave them the figures which were given to me by the Canal Company and just as they were received. I could not tell you now.

The CHAIRMAN. And you gave the figures to them as expenditures which were made by the Maritime Canal Company?

Mr. MENOCAL. Yes, sir.

The CHAIRMAN. Without reference to the fact of whether they were expenditures made by the Construction Company?

Mr. MENOCAL. Well, you are a little mixed there; I do not know how to answer that question. All expenditures were made by the Construction Company, and afterwards paid for by the Maritime Company, but what the arrangement between the companies was I know nothing about. When the Commission was appointed certain information was sent through me to be laid before them, and the books in Greytown were open to them. They spent several days in examining the books with the bookkeepers, and from them they got their notes. That is all I know about it. I was no part of the Commission.

The CHAIRMAN. You were a member of both companies as a stockholder?

Mr. MENOCAL. No, sir; I was an engineer of the Construction Company.

The CHAIRMAN. Of the Construction Company?

Mr. MENOCAL. Yes, sir.

The CHAIRMAN. Were you not a stockholder or an officer in both companies?

Mr. MENOCAL. I was a stockholder to some extent; I had about 40 or 50 shares of the Maritime Company's stock, which I have now, but I was not an official of the Maritime Company at all, and I had nothing to do with the financial affairs of either of the two companies.

The CHAIRMAN. Were you not conversant with the contracts existing between those two companies?

Mr. MENOCAL. I never saw them.

The CHAIRMAN. Well, you knew in general terms what contracts had been made?

Mr. MENOCAL. I knew contracts had been made, but I never saw them. My connection with this enterprise, Mr. Chairman, is entirely professional, and I have a small interest pecuniarily.

The CHAIRMAN. I am not pursuing that line, however, for any other purpose than to elucidate from you, if I can, the fact that you knew of the character of the management between the two companies.

Mr. MENOCAL. I never saw the contract. I only knew what I have stated to the committee frankly, that so far as I know, these contracts involved a certain arrangement by which the Construction Company was to be paid in what I call securities, both bonds and stock; but how much, and in what proportion, in what amounts, and at what time I do not know. I never investigated it or bothered myself about it, as I had nothing to do with such affairs.

The CHAIRMAN. Do you not know generally that there was a contract by which the Maritime Company was to turn over to the Construction Company all of its assets, both bonds and stock?

Mr. MENOCAL. I could not answer that question positively; but I have an impression that it was not all the assets. How much it was I do not know. I never saw the contract, but I have the impression that a certain amount was to be retained by the Maritime Company, but how much I do not know.

The CHAIRMAN. You made the negotiations between the Maritime Company and the States of Nicaragua and Costa Rica?

Mr. MENOCAL. No, sir; I did not. The Maritime Company was not in existence at the time. I made these negotiations for an association which started among four or five friends, who were interested in the canal, and they raised a certain sum of money. I will tell you how much it was. There was $300,000 contributed, each one putting in $5,000 and in some cases the shares of $5,000 were divided into subshares of $1,000 each, and so they raised this amount of $300,000.

With this sum of $300,000 I was requested to go to Nicaragua and get a concession and to Costa Rica afterwards.

The CHAIRMAN. Did you procure the concession for the sum of $300,000?

Mr. MENOCAL. No, sir.

The CHAIRMAN. What more were they to get?

Mr. MENOCAL. What, sir?

The CHAIRMAN. What in addition to the $300,000 were you to give those two States for the concession?

Mr. MENOCAL. I only gave the Government of Nicaragua $100,000. Later on I paid the Government of Nicaragua $50,000 for the right of way between the lake and the Pacific, which was provided for in the concession. One of the conditions of the concession was to the effect that the company, when organized, and after work was commenced, was to pay to the Government of Nicaragua $50,000 for the right of way between the lake and the Pacific.

The CHAIRMAN. Were those two sums, $100,000 and $50,000, the total consideration to be paid to Nicaragua?

Mr. MENOCAL. That is all I paid.

The CHAIRMAN. Was there anything reserved—were you to pay anything more?

Mr. MENOCAL. No, sir; not by the terms of the concessions, except a certain amount of stock.

The CHAIRMAN. What was that?

Mr. MENOCAL. Six per cent.

The CHAIRMAN. Was that agreement made at the time of securing the concession?

Mr. MENOCAL. Yes, sir; those were the conditions of the concession, that the company would turn over to the Government of Nicaragua 6 per cent of its stock and to Costa Rica 1½ per cent, if I remember right.

The CHAIRMAN. Was that stock ever delivered?

Mr. MENOCAL. Well, I have to say about that that I do not know.

The CHAIRMAN. You have never delivered it?

Mr. MENOCAL. I never delivered it personally.

The CHAIRMAN. Have you any knowledge upon the subject that enables you to form an opinion?

Mr. MENOCAL. Only an opinion. I am not prepared to show you that it was delivered, but I have an opinion formed that the stock was sent to Nicaragua to the agent of the company to be delivered to the Government of Nicaragua, but what became of it, whether it was actually delivered, or where it is, I do not know; but I have the impression from conversations that I heard in the offices in New York, and also what the agent himself told me, that this stock had been sent to him to be delivered to the Government of Nicaragua.

The CHAIRMAN. Do you remember when that was?

Mr. MENOCAL. That must have been, sir, between 1889 and 1890, within those two years, but I could not tell you exactly the date. From the time this agent remained in the country, I should suppose it was between 1889 and 1890.

The CHAIRMAN. On the occasion when you were representing the expenditures made by the company to these commissioners of Nicaragua, was the item of expenditure for the navigation of the river and lake included?

Mr. MENOCAL. I think so.

The CHAIRMAN. Do you remember what amount?

Mr. MENOCAL. No, sir; I think that a sum of money was included in the expenditures for this purchase.

The CHAIRMAN. What was the amount paid there for that right?

Mr. MENOCAL. I had nothing to do with that negotiation and I do not know that I have any right to say here how much it was, but I believe, for what my information is worth, it was $300,000. I had nothing to do with it.

The CHAIRMAN. Do you know who negotiated the contract?

Mr. MENOCAL. The company in New York. I could not mention the names of anybody. I was not here at the time; I was in Nicaragua. Those are matters in which I never concerned myself.

The CHAIRMAN. At the time you were procuring this concession from Nicaragua was the fact that there was a grant in perpetuity—an exclusive grant already made to parties to navigate the river and lake—known to you?

Mr. MENOCAL. Not in perpetuity.

The CHAIRMAN. It was not in perpetuity?

Mr. MENOCAL. No, sir.

The CHAIRMAN. For what period?

Mr. MENOCAL. I think the gentleman who had the grant had four or five more years to run, and when the company attempted to put steam tugs and lighters, etc., in the river he protested. The Government of Nicaragua sustained him in his claim that no one had the right to navigate the waters of the lake or river but himself until his contract expired. If you consult the concession, you will see there a stipulation to the effect that at the expiration of his privilege the Canal Company would have the privilege of navigating all the waters of Nicaragua, not only navigation, but control. The Governments of Nicaragua and Costa Rica gave the company the right to flood public lands, dam streams, divert streams, raise the lake, to take possession of the country, and to build that canal as they wanted it. The whole country is turned over to the company with the only provision that such private lands as are damaged by the works of the company shall be paid for at their actual value. That is the only restriction, but the company has the right to go on and flood the whole country if necessary.

Mr. STEWART. Have you any interest pecuniarily, or otherwise than professional interest, in the canal project at the present time?

Mr. MENOCAL. I have some interest in the company.

Mr. STEWART. To any large extent?

Mr. MENOCAL. No, sir; very little. These are private affairs. I have repeated here that I have an interest, and I always have had. I was one of the first promoters who obtained the concession. I have faith in the enterprise as being a great work, and my only ambition is to see it completed. If I had a million dollars to-day, I would put every cent of it in it.

Mr. STEWART. My only object was to show your interest was a very small item, and therefore would not control your judgment.

Mr. MENOCAL. It is only small because I am a poor man. If I had more, I would put it in it.

Mr. BENNETT. That lake and river navigation company whose franchise was afterwards assumed by the Canal Company began from what point on the lake to what point on the river?

Mr. MENOCAL. They had the right to navigate all the waters of the San Juan River and Lake Nicaragua.

Mr. BENNETT. Is the stream navigable from Fort San Carlos to Greytown now?

Mr. MENOCAL. Not in the dry season.

Mr. BENNETT. In the wet season is it navigable?

Mr. MENOCAL. Yes, sir; it is from six to eight months a year, dependent upon the rainfall, by stern-wheel steamers, which generally draw about 3 feet. They go as far as Castilio in the rainy season without any transfer, and at Castilio they transfer to another river steamer, and on the lake to another steamer; so even in the rainy season, when the river is high, two transfers are necessary—one at Castilio and one at the lake.

Mr. BENNETT. Is there water communication between the lake and the Pacific here?

Mr. MENOCAL. No, sir.

Mr. BENNETT. That is not navigable?

Mr. MENOCAL. No, sir.

Mr. BENNETT. These streams are not navigable?

Mr. MENOCAL. No, sir; never have been.

Mr. CORLISS. How large is that little body of water indicated on the western side there?

Mr. MENOCAL. It contains 4,050 acres in area.

Mr. BENNETT. It is more in the nature of a swamp?

Mr. MENOCAL. No, sir; it is a very fertile, beautiful valley; there is no swamp there.

Mr. DOOLITTLE. I want to ask a few questions now. I would like to have the sense of the committee about this, whether they would like to have from Mr. Menocal a detailed history of the line he ran there, and take the whole subject up in its order as to what he did do while there, in detail, and a history of these surveys and examinations from top to bottom. If it is essential, in the opinion of the committee, why of course Mr. Menocal stands ready here to cover that entire ground, every foot of it, from Greytown Harbor to the lake, and from the lake to Brito, if that is thought to be advisable by the committee. That is a matter which occurred to me the other evening in speaking to him.

The CHAIRMAN. What good will it do?

Mr. DOOLITTLE. I do not know what, I am sure.

Mr. JOY. I will state that at one of the meetings of the subcommittee at which you were not present, and which took place at my house, that matter was gone into with some care, and it is embodied in a typewritten report, which of course has not been corrected by Lieutenant Menocal, because he has not been here, but it can be used to avoid the consumption of time. I do not know it will cover the whole ground, but it was taken down and——

Mr. MENOCAL. I have surveyed the lower route, the upper route, the west side, and run lines myself personally. I have run trial lines on the west side and have made surveys of the river and have located the line along the banks of the river as far as Greytown; have made detail surveys of the streams of the San Juanillo in 1876, and then I ran a preliminary line in 1885 from Ochoa to Greytown, and from 1888 to 1891 I almost lived on that ground.

Mr. STEWART. Colonel Ludlow said you revised your estimates to conform with their estimates. Will you explain that?

Mr. MENOCAL. I do not see how we could do that when I had not seen the estimate of the board. The estimate of the board was not made at the time.

Colonel LUDLOW. I made no such statement.

Mr. MENOCAL. If that statement was made it is incorrect, because

this revised estimate was made before the board's report was made public.

Colonel LUDLOW. Colonel Ludlow has made no estimate, if you please.

Mr. PATTERSON. I understand there have been two estimates made by Mr. Menocal, and that he has revised in some respects the first estimate he made, and I have been confused a little bit in this way whether Mr. Miller in his very lucid discussion of this matter based his remarks upon the first or the second estimate.

Mr. MENOCAL. If the committee will allow me, I would like to say a few words in regard to that. The estimate has been revised three times.

The CHAIRMAN. Give the dates of the three.

Mr. MENOCAL. First in 1889, when the original surveys were made and the borings had not been completed. That has not been printed and does not appear in the records. Then in 1890, after the borings were made, a revision was made and the estimate which I had made before in 1889 was noted "corrected to that date." Since that date we have made very extensive and very valuable examinations in Nicaragua in connection with the sites of locks, embankments, and all that work which is necessary to perfect and complete the plans of the canal, the working drawings you may say, and these examinations were carried on up to the time when work was stopped. The last money spent by the company was to make diamond-drill borings at the site of Tola Dam.

Mr. STEWART. Excuse me one moment; I want to make my statement fuller. Were your later estimates controlled by the estimates of the board?

Mr. MENOCAL. The estimates of the board had not been made up to that time.

Mr. PATTERSON. What is the date of your last estimate?

Mr. MENOCAL. I think it is July, 1895. I will come to that if you will allow me to proceed in the order in which the matter has taken place.

Mr. PATTERSON. Very well.

Mr. MENOCAL. As I stated, we made extensive examinations of the site of the embankments and the dams, and made deep borings at the Tola Dam, and made numerous borings at the site of the three locks on the east side, and we prepared ourselves to make the final drawings. The estimates, which had been made up to that time, July, 1895, had been based only on the information we had up to the date of those estimates, and the last estimate made in 1895 is based on the data that had been accumulated up to that time. Now, in connection with that, it would be well for me to refer to the remarks which have been frequently made here—that the company have been unable to present to this board detailed drawings of all the works proposed. That is very true. That statement is correct. We were not yet in a position to make those detailed drawings. They were to be made when all the information had been gathered. They were to be the final drawings, on which the work was to be contracted for. In most cases we had the necessary information, but in others, not enough to satisfy me; and I was proceeding with this investigation when the work stopped in Nicaragua.

The estimates were made, as I said, on the information obtained up to date, and as the work is mostly all excavation except locks and dams, the estimates for locks and dams were based on preliminary sketches, you may call them. A lock is a very simple thing to calculate approximately. You have the foundation, side walls, and gates. Those are

the principal parts, and any practical engineer when he knows the ground on which he is to build his work can come within a small percentage of what it is going to cost and what amount of work he has to do. The estimated cost is a question of opinion and may differ greatly between engineers and contractors. These working drawings were not yet made, and when this board applied for them they were told frankly we did not have them. A number of them had been commenced, but not advanced sufficiently to enable me to present them for the criticism of this board, as they were not yet perfected.

Now, I am going to refer here to an instance to show you how practical engineers generally proceed in a matter of that kind. I am going to refer to the construction of the enormous bridge that is now being built over the East River in New York, much larger than the present bridge, with a larger span, wider and much heavier, the whole structure resting on two piers. Eminent engineers have made plans for that bridge and estimated the cost of it. These plans and estimates have been approved by the board of public works of the two cities. The cities have agreed to build this bridge on these plans and estimates, and a large sum of money has already been spent on the right of way and preparatory work. Work you may say has been commenced, and an eminent engineer has been put in charge of it. Only three weeks ago arrangements were made and borings were commenced at the sites of these piers; and as to final borings, to ascertain at what depth the rock ledge lies on which the piers are to rest, up to the middle of last week only one had been sunk to the depth of 70 feet below high-water mark, where they think a solid ledge of rock will be found. That is the only possible way to do work of that kind, and one would be a poor engineer if he does not change his plan if he sees an opportunity to do so to advantage.

Mr. DOOLITTLE. To the advantage of the work?

Mr. MENOCAL. Certainly. He would be a poor engineer if he does not sleep over his plans, exerting his mind on the best methods to overcome the difficulties constantly arising in works of this kind, and during the night something may occur to him as to how best to do this, that, or the other, and it is his duty to do it. What engineer has undertaken a work of that kind that has not introduced changes in it? I would like to see one. You can design a bridge that rests on two rocky bluffs, and of course design at the start braces and counter-braces and upper and lower cords, etc.—in fact, every part of the structure—but that is a fixed piece of mechanical work which you can locate and work out in detail beforehand and definitely. But when you have to deal with the excavation of rivers, swamps, and hills and difficulties connected with building dams, locks, etc., which an engineer can never foresee exactly in all and every detail, he would be a very poor engineer if he does not change his plans when he can do so to the advantage of the work. Very well; that is what I have done and what I will do again.

This plan presented here as my plan of the Ochoa Dam is an obsolete plan. It is merely a sketch made when we had not yet made borings at the site of the dam. It has no value whatever. It was not given to this board as the plan of the Ochoa Dam, and the board had no right to bring it here, because they were told it was not a final plan for the dam, but a preliminary study. It may be very true, as they say, that they had great difficulties in estimating for that dam and other works proposed, but that is their business, not ours. If they can not estimate with sufficient approximation for a lock, after we give them a

foundation for that lock, as shown by numerous borings—well, they ought to.

Mr. PATTERSON. There is just one question in that connection that I desire to ask you. You heard Senator Miller's statement before the committee yesterday, I suppose, and a good deal was said about propositions that were submitted here by Mr. Treat?

Mr. MENOCAL. Yes, sir.

Mr. PATTERSON. And then about estimates made and concurred in by Mr. Donaldson, an English engineer?

Mr. MENOCAL. Yes, sir; I heard that.

Mr. PATTERSON. Now, was the proposition submitted by Mr. Treat based upon the estimate of 1895 or the estimate of 1890?

Mr. MENOCAL. You can see by the date of the proposition that it was made on the estimate of 1890.

Mr. PATTERSON. And Mr. Donaldson made his estimate on the 1890 basis?

Mr. MENOCAL. Certainly; the date will show that. There is another question which has been brought up here, and a great deal has been said about it, and that is about the hydraulic data and the rainfall. It is said about the hydraulic data we had not enough. They have been trying to make me appear in a false light before this committee because I had stated before that we had information enough to enable me to arrive at conclusions as to the effect which the flow of the streams and the rainfall would have on the work which we had proposed in Nicaragua. Now, you will find in my written statement that this hydraulic data, to be of any value, would have to be observed for a long number of years. The rainfall of one, two, three, or four years is not going to give very much light. The observation of years may be entirely upset by the results obtained in the last year.

There are only two things we have to consider in this case—the minimum and maximum flow of the river. We know sufficiently close what the minimum flow is. That is what will guide us in determining how much water we can use to work the canal in the dry season, and even that is very much in doubt, because when we raise the Ochoa Dam and increase the flooded area and create a larger reservoir we will have a larger lake to draw from. No engineer has ever questioned the proposition that we have water enough in this immense lake of 2,700 square miles and the additional lake created by the flooded area to work that canal. Then as to the maximum, I have ascertained that as far as it has been possible to do so. There has been only one large flood in Nicaragua while I have been there that I have been able to observe, and that was in 1889. It was gauged not by myself, but by my assistant engineers, and it was well and accurately done. While I have that gauging, I know the river rises considerably more. There are indications that it rises more than shown by that gauging. For that reason I have taken the result of that gauging and increased it by 50 per cent. Then in proportioning weirs for the discharge of the surplus waters, which we may have to dispose of in the rainy season, we provide for double that amount; that is to say, that instead of 60,000 cubic feet per second we have provided for 120,000 cubic feet, with a maximum fluctuation of 4 feet over weir crest, a fluctuation which is inevitable.

Now, this question of controlling the river and lake, of course, is a problem on which engineers will differ, and it is useless to bring it up here. I think it can be done inside of 2 feet. Now, the rise of the river has been represented here as an enormous rise of 21 feet or 20 feet at

Machuca Rapids, and at other places of 12, 14, and 15 feet. Let that be. What does it show? That water always rises suddenly after a heavy rainfall or even after a moderate rainfall at the rapids. There is a contraction of the channel where that elevation was taken in the river, where the width of the river is less than half the average. There is a stream coming into the river San Juan at that very point at right angles to it, not a very large stream, but a small torrent, that comes from the very high mountains, and there is also an island in the center of that narrow gorge, and consequently an accumulation takes place there which is inevitable. Such an accumulation takes place at the foot of all rapids. At the head of the same rapids the rise probably was not 10 feet, and there is a series of rapids from Toro to Machuca, where the river can not assume any regular regimen. It is changing there all the time on account of the rapids, but take it above the Toro Rapids, where the river has an even inclination, uniform banks, with even elevation and a regular regimen, and there you will find that the river does not rise more than we have stated, or very little more. In that section the river is changing constantly, and nobody can say how high or how low it will be from day to day, but it certainly can not rise 8, 10, or 20 feet, because in such a case the river would be running upstream toward the lake. You get the river to rise above 8 or 9 feet, and it would run back to the lake instead of running down.

Mr. DOOLITTLE. Are you through with that?

Mr. MENOCAL. Yes, sir.

Mr. DOOLITTLE. I wish you would state to the committee when it was you became an officer of the Government, in what year?

Mr. MENOCAL. In 1872 I was employed by the Government to commence the surveys. I was commissioned as an officer of the Government on the 25th of July, 1874.

Mr. DOOLITTLE. Will you state to this committee what works you have had charge of since that time?

Mr. MENOCAL. I have been making all the explorations in that country to develop and design this canal route, and up to the time I found this route no engineer had ever proposed a canal there except by following the bank of the river.

Mr. DOOLITTLE. But I am asking you now about what Government work you have done?

Mr. MENOCAL. That was a part of Government work. When I made that survey of 1885 I was working for the Government. When I made the survey of the west coast of the lake I was under orders of the Government. I also made surveys for the Panama Canal as chief engineer, as an officer of the Navy in charge of the explorations. I was ordered to the Paris Congress where the question as to which was the best route for the canal across the isthmus was considered; I was sent there as one of the commissioners for the United States Government. During all the time in which I have not been in Nicaragua I have been actively engaged in works here done under the Navy Department in the construction of dry docks, piers, and the gun shops at Washington, which I designed and built myself, and in addition to those duties I had been engaged for eight years as consulting engineer in the Navy Department, a position which Mr. Endicott holds to-day. I held that position before he was ordered to that duty.

Mr. DOOLITTLE. In what year were you in the same position now occupied by Mr. Endicott?

Mr. MENOCAL. For seven or eight years previous to his detail. When I was given leave of absence to go to Nicaragua to take the position as

chief engineer of this canal company, I requested to be detached from that duty, and Mr. Endicott was then ordered to take the place which I had occupied for seven or eight years. Since then I have been constantly at work. I have been ordered by the Government to numerous boards to solve difficult questions of engineering. I have designed a good many important works for the Navy Department which have been carried out, and I have now fourteen or fifteen contracts to look after for building docks, dry docks, etc., at the navy-yard, New York.

Mr. STEWART. What time did Davis go to Nicaragua?

Mr. MENOCAL. He was first employed by me to go to Nicaragua at the end of 1887. Then, again, I employed him to go back there in 1889, I think.

Mr. STEWART. You made surveyings and borings too?

Mr. MENOCAL. Yes, sir; Mr. Davis was one of the late arrivals. I started the surveys in 1872, and Mr. Davis did not go to Nicaragua for the first time until 1887.

Mr. CORLISS. You spoke of the bridge which is to be built at New York.

Mr. MENOCAL. Yes, sir.

Mr. CORLISS. Was that project undertaken by those cities and the money appropriated upon estimates alone, or were detail plans prepared upon which——

Mr. MENOCAL. Well, there were preliminary plans for the superstructure and piers. The superstructure may remain as it was originally designed; but the plans for the piers for the support of the whole superstructure, of course, will not be made until borings have been made, and that is being done now, and the first one was sunk only last week to a depth of 70 feet.

Mr. CORLISS. Was not the character of the earth and rock well known in the locality?

Mr. MENOCAL. It was estimated approximately. They had some borings made with an auger and found something they thought to be rock, and they made their calculations accordingly, and they may have increased the estimates by a large percentage to provide for contingencies. But the fact remains that after this work had been projected and plans completed for the superstructure, and actual work commenced, they are now sinking rock-drill borings to determine the depth of the rock ledge. I think Mr. Bennett, from Brooklyn, knows that very well, and one can see every day in the Brooklyn Eagle to what depth they are reaching. They went down so many feet and passed rock and struck clay, and then rock again, until they came to rock which they believed to be a rock ledge 70 feet below high-water mark.

Mr. CORLISS. Do you know of work that has been undertaken by private enterprise involving so large a sum of money without full detail plans before the investment of capital in it?

Mr. MENOCAL. That is generally the case, except, of course, when you have a building or a work that is concentrated, when there is no reason why you should not prepare all details before work is commenced. But an examination is generally made by engineers sufficient in detail to satisfy them that the work is practical and can be done within a certain limit of cost, and then unknown quantities are provided for by a percentage for contingencies, as I have done in this case. I have added 25 per cent on the original estimates, and in the last estimate I reduced it to 20 per cent, for the reason that we have gained so much information over what we had before, and the methods of doing work

of the kind we have to do in Nicaragua have been so greatly improved in connection with the excavation on the Chicago Drainage Canal and other works of a similar kind, that it would be almost improper, I should say, for an engineer to repeat or to adopt the same prices he thought sufficient six or seven years ago. If an engineer thought that $1.50 per cubic yard for rock excavation was a fair price ten years ago, why he ought to know that the methods which have been invented since and put in successful operation would enable him to reduce his estimates in proportion to the advances which have been made in the science of engineering.

Mr. CORLISS. What is the total amount of your estimate for this entire project?

Mr. MENOCAL. I think the last estimate, with 20 per cent added, comes to some $69,000,000 or $70,000,000.

Mr. PATTERSON. And is in round figures $70,000,000?

Mr. MENOCAL. Yes, sir; about that.

Mr. CORLISS. That is on a plan of a canal with only 70 feet in width at the locks?

Mr. MENOCAL. Seventy feet at the locks, and the whole canal is 120 feet in the earth sections, 100 in the rock sections, and 125 in the river, and 150 feet in the lake.

Mr. CORLISS. Have you made any estimates of the cost at the width suggested of 90 feet?

Mr. MENOCAL. No, sir. It is very easy, it is a comparatively small sum of money, which will be more than covered by the 20 per cent added to the cost itself. It is a very small amount in proportion. I do not think it would be more than 10 per cent, or something of that kind, of the estimated cost of the locks.

Mr. PATTERSON. Now, the board of commissioners appointed by the President have made suggestions in regard to various changes which they think ought to be made in the general plan of the construction of this canal. For instance, that the locks ought to be larger, that the river ought to be deeper and wider, that the channel cut out in the lake ought to be wider, and various other changes which are more readily suggested to your mind than mine. Have you made any calculations now based upon those premises as to what will be the cost of the canal?

Mr. MENOCAL. No, sir; I have not. I suppose the calculations of the board are correct. I have treated this question of changes in my original paper, and as I have stated I believe the computations of the board to be correct.

Mr. PATTERSON. The estimate of the board, I believe, is $133,000,000?

Mr. MENOCAL. If I remember correctly, it is, and I suppose their calculations are correct. Whether the changes are desirable or not depends upon circumstances, but I have no doubt the figures are correct, and they have also corrected an error which was made in our estimates on the amount of excavation in the river. The error was transferred from one of the Government's reports to the company's estimate. The company adopted the Government report in estimating for work on the river, and the amounts contained in that report of 1885 were merely transferred. Do you follow me? They were transferred from the Government report of 1885 to the company's estimate. There was an error made in transferring this estimate of 1885 and it went into print in that way; the error was not discovered, and when the commission were examining our figures and verifying them they discovered this error, which I admit, and the estimates of the company must be corrected to meet that discrepancy.

Mr. PATTERSON. In saying your estimate is $70,000,000, is that 25 per cent added?

Mr. MENOCAL. This last estimate, as I stated, provides for 20 per cent, and in the previous estimate it was 25 per cent.

Mr. DOOLITTLE. With the 20 per cent added it makes $70,000,000?

Mr. MENOCAL. About; in that vicinity.

Mr. DOOLITTLE. What per cent did the board add?

Mr. MENOCAL. I think 20 per cent.

Mr. PATTERSON. And by adding 20 per cent they reached $133,000,000?

Mr. MENOCAL. Yes, sir.

Mr. PATTERSON. So there is a difference between you and the board of $63,000,000?

Mr. MENOCAL. Yes, sir.

Mr. CORLISS. Assuming that the plan and the changes suggested by the Commission were adopted as to enlarging and extending the work, in your judgment, what would the entire project cost?

Mr. MENOCAL. I have not figured it.

Mr. CORLISS. Do you think it would reach the sum they have estimated?

Mr. MENOCAL. It is very simple to compute, and the commission's figures I think are correct. I have no reason to doubt them, and applying my prices to the dimensions proposed by them it would be very easily arrived at.

Mr. DOOLITTLE. But your prices do not agree with the commission's?

Mr. MENOCAL. No, sir. They do not in most cases.

Mr. CORLISS. This proposition of Mr. Treat read by Senator Miller yesterday was based upon your plan?

Mr. MENOCAL. Yes, sir; my plan and estimate for prices.

Mr. CORLISS. So if the plan adopted by the commission was approved it would increase the expenses $33,000,000?

Mr. PATTERSON. $63,000,000.

Mr. MENOCAL. It would increase it considerably.

Mr. CORLISS. Over and above the estimate of Mr. Treat?

Mr. MENOCAL. Not quite the same amount, because Mr. Treat has agreed to do the work at a less price, based on my estimate. The quantities may be changed, you see, but the unit price, as I understand, of Mr. Treat will be about the same as mine.

Mr. CORLISS. But Mr. Treat's proposition to build the entire canal was on your plan?

Mr. MENOCAL. Yes, sir.

Colonel LUDLOW. What date?

Mr. CORLISS. It was read here yesterday.

Mr. MENOCAL. Of 1890, and not 1895.

Mr. CORLISS. I understand that. I am going to add that. So we have no proposition from Mr. Treat to construct this canal throughout of the capacity as suggested by the commission?

Mr. MENOCAL. No, sir.

Mr. PATTERSON. We have no propositions coming from Mr. Treat to construct the canal upon estimates submitted by you in 1895?

Mr. MENOCAL. No, sir.

Colonel LUDLOW. Before you adjourn I would say I would be glad to have the indulgence of the committee for the matter of an hour at your convenience.

Mr. DOOLITTLE. Mr. Chairman, I shall object, very decidedly. This Commission came before this committee with their report. Then there was a reply by Senator Miller, and also by Mr. Menocal. Then these

gentlemen came here and have consumed a great deal of time, and they have gone over this subject very thoroughly and brought out some entirely new matters in their fresh verbal statements before this committee. Now, then, in simple rebuttal of those statements, it was asked that Senator Miller and Mr. Menocal appear before the committee to close their rebuttal, which they did. Now, then, if there is to be a surrebuttal, and a rebuttal added to that, and all the time taken up by these gentlemen, of course the labors of this committee are never going to close and we will never be finished. Of course, if Colonel Ludlow here is permitted to appear again and produce new matter, why then we should have to have Senator Miller and Mr. Menocal again. If they disclose new matter we have to have Colonel Ludlow again, and after Colonel Ludlow, Senator Miller and Mr. Menocal again. I move you, Mr. Chairman, that the committee declare the hearings closed on the subject of Nicaragua Canal Company.

Colonel LUDLOW. May I have the indulgence of the committee for two minutes, Mr. Chairman?

Mr. PATTERSON. Mr. Chairman, I will just say this. So far as I am concerned, I am very anxious to arrive at the truth of this matter. These gentlemen who have been discussing this matter are professional gentlemen, they have some differences of opinion about it, they both represent the Government. I think both the Commission and Mr. Menocal may be professionally biased, as all gentlemen are. I know wherever I am professionally interested I am biased more or less; but they are honorable gentlemen, and they are trying to present the truth of this case, and so far as I am concerned I would be very glad to hear Mr. Menocal make any further statement before this committee which occurs to him, and I would be very glad to hear Colonel Ludlow make any statement that occurs to him; and I want to say now, that if this committee allows Colonel Ludlow to come before it and make an additional explanation, and anything should occur to which Mr. Menocal would like to reply, he should have the opportunity, so far as I am concerned.

This is a very great proposition. It is one involving very great interests, and one that is very fascinating to me. There is no man around this board who wants to see the Nicaragua Canal constructed more than I do, and no man feels more disposed to study the proposition and to arrive at the truth of it than I am, but, so far as I am concerned, I am no engineer. I have looked upon what these gentlemen say very much as a juror would, weighing it as best I can and seeking to arrive at a conclusion that I think will be satisfactory to the American people and the public interests, and if Colonel Ludlow desires to make a further statement before this committee I insist that he ought to have the opportunity to do it, and in that connection I want to say that if anything occurs to which Mr. Menocal, who is here, would like to reply at the same session I want him to make any explanation or any further suggestions, or any other comment which may occur to him. That is the way I feel about it, and I want these gentlemen to feel that they have had the fullest opportunity of discussion and the fullest opportunity of explanation. Now, something may have occurred to Colonel Ludlow in the progress of this discussion this evening which has not occurred to any member of the committee. He is a professional man and we are not, and if he desires to make any further statement before the committee I think that the interests of the public service require we should hear him. That is my idea about that.

Mr. SHERMAN. I move that we go into executive session, and we have the right to decide what further we shall do by ourselves.

Colonel LUDLOW. Before putting that motion——

Mr. SHERMAN. Mr. Chairman, I have moved——

Colonel LUDLOW. Will you permit me to briefly state our position in the matter; I will simply state our position and leave the matter with the committee?

The CHAIRMAN. I think we understand that.

Mr. SHERMAN. I ask that my motion be put.

The CHAIRMAN. It is moved that the committee now go into executive session.

The motion was adopted, and therefore the committee went into executive session.

THURSDAY, *May 7, 1896.*

The Committee on Interstate and Foreign Commerce this day met, Hon. William P. Hepburn in the chair.

STATEMENT OF COL. WILLIAM LUDLOW—Resumed.

Colonel LUDLOW. Mr. Chairman and gentleman of the committee, I have no desire to protract this hearing unduly, or to take up the time of the committee here in any way, but there were some points in connection with the testimony given by Mr. Miller and Mr. Menocal which I regard as very important and which I think the committee will also think important and which I desire to submit as a part of the record. I will take them up, if you please, and treat the matter as briefly as may be. In regard to what Mr. Miller may have said personally about me I will not trouble the committee. I recognize that there is a considerable disparity between Mr. Miller's views and my own as to what might be considered decent or proper conduct for an officer in the service or out of it, but I am content to leave the gap unfilled. We have our own criterion of those matters, and from our point of view for an officer in the service or any other responsible position, one duty is to tell the truth and to wrong no man, and I have always endeavored to follow that. Whatever the contrast may be between that view and others it is not for me to indicate.

I will now take up the technical matters, but there is a point to which I wish to refer at the same time, as having a personal relation, which is in reference to Mr. Davis, for the introduction of whose name in this matter I am responsible; and I should regret it extremely that Mr. Davis should suffer in any wise, and the only satisfaction that I have about the accusations made against him is that they give me an opportunity very promptly to refute them. I have submitted to the committee Mr. Davis's record when he was an officer of the Canadian Pacific Railroad Company, and the committee is in possession of the testimonial presented to him by the direction of the road as a mark of very distinguished services. I have submitted his record while in the employ of the District government, in which the responsible officials here, for years thoroughly cognizant of Mr. Davis's services, unhesitatingly testify to his ability and integrity, and declare their judgment of Mr. Davis as an individual whose assertion they would not hesitate to accept. That carries the matter down to the period of his employment by the canal company. Of this Mr. Davis did not tell us much, except as we incidentally gathered it, but we had no reason to believe he was in any other sense than a trusted and capable employee of the company. He certainly occupied a very responsible position under them, and if my recollection is not at fault, he was retained almost until the close, and that the final severance of his relation with the company was made

upon his own resignation; that he had resigned while still employed in a very responsible position there.

Mr. DOOLITTLE. Did you not hear Senator Miller state here that he was discharged?

Colonel LUDLOW. Yes; and I heard Senator Miller say other things here, Mr. Doolittle. There is no evidence of that fact here submitted, however, either by Mr. Miller or by Mr. Menocal. It would have been easy to secure a certification of that fact, if it were one.

Mr. DOOLITTLE. I do not know that Senator Miller's word needs a certification.

Colonel LUDLOW. I know this: He was employed until a very late day by the company in a responsible position, and they had imposed upon him double duties down there. I have endeavored to refresh my recollection about what I had learned about it, and I understand that he believed that he was entitled to an increase of salary from the company in consequence of the extra duties imposed upon him; and the company acceded generally to the equity of his demand, but was unable to fulfill it, and Mr. Davis, believing that he had been promised compensation, and the company withholding it, took some legal means to procure it——

Mr. DOOLITTLE. In which he failed in the courts?

Colonel LUDLOW. That I know nothing about; but as to whether a man should or should not resort to legal methods to get what he believed he should have is certainly not any imputation upon his integrity, and I desire for my own part to say in behalf of myself and my colleagues, who were associated with Mr. Davis, day in and day out, for six months, that we are just as convinced as any men could be by knowledge gained by a very close and intimate connection with him that the man is absolutely honest, that he is capable, and of a sturdy integrity which I do not think could be shaken by any means.

Mr. DOOLITTLE. Do you not think you have used that man Davis with all the force that you can use him for the impeachment of Mr. Menocal without further bolstering?

Colonel LUDLOW. I am responsible for the introduction of Mr. Davis's name, and he has been gratuitously assailed, and if you will permit me to complete my remarks——

Mr. DOOLITTLE. If you feel now the point of your instrument is blunted, I think the time has passed by for the sharpening of it for the purposes of this case.

Colonel LUDLOW. Not at all. I think, Mr. Chairman, if you please, I should prefer to continue my remarks. If Mr. Doolittle has anything pertinent to say, he has had all the time he wanted, and I have no doubt the committee will give him as much more as he wants, but I do not want him to take mine.

Mr. DOOLITTLE. You are simply appearing before the committee at the request of the committee——

Colonel LUDLOW. I represent the United States Government.

Mr. DOOLITTLE (continuing). And I happen to be a member of the committee and have my rights and propose to stand by them, and you shall not trample over them, with all your topheaviness——

The CHAIRMAN. I submit that is not in order.

Colonel LUDLOW. I thank you; I have no right to call anyone to order, nor do I think the committee as a whole or anybody will accuse me of any lack of courtesy to anybody personally. I represent the Government of the United States here. I represent the Board of Nicaraguan Canal Engineers, appointed pursuant to an act of Congress and appointed by the Executive, and the members of the board here have been treated

in every respect by the committee with that consideration and courtesy without which our duties, difficult enough in any case, would have been absolutely impossible, and yet we have from time to time been put in the position as if we were somewhat in the nature of recalcitrant witnesses from whom the truth had by some means to be extracted. We represent the Government of the United States. Mr. Doolittle says he is a member of this committee, and of course he is. What interest does he represent here other than the same interest?

Mr. DOOLITTLE. And I will tell you if you desire to know, since you have asked the question, that I represent the interests of my constituents and as an accredited Representative in Congress.

Colonel LUDLOW. That is quite true.

Mr. DOOLITTLE. And that is the only interest I represent here. If you desire to make any further reflections, of course you are fully at liberty to do so, doubtless.

Colonel LUDLOW. Is that part of the public record?

Mr. WANGER. I hope it is not.

Colonel LUDLOW. It is a little unseemly and undignified, and I do not advocate it.

Mr. WANGER. I suggest we go back——

Colonel LUDLOW. I challenge in this room, or out of it, anyone to say that in any respect I have failed in all due courtesy to everyone connected with this matter, both in our published report and in all the public utterances we have made here. Such personalities as have been introduced into this discussion have been brought in by others than ourselves. We have met them on the floor of this committee room, and we have taken means to refute them, and I believe I am justified in doing so, and that the public will uphold us in the doing. We do not propose to have the dignity and importance of this matter discredited to a mere altercation.

I will continue, Mr. Chairman, what I had to say about Mr. Davis——

The CHAIRMAN. Proceed.

Colonel LUDLOW (continuing). Because I want to finish that matter up. I wanted to say in behalf of the board, myself personally, and my colleagues, that we have absolute confidence in Mr. Davis's capacity and integrity and we find no reason to doubt it. That he having left the service of the company should be prepared to place his local knowledge of the physics and conditions there at our service was quite to be expected. He is an engineer and earns his living, and among the many applications with which we were flooded we selected those whom we thought would be the most useful to us. Mr. Davis's services down there were simply inestimable. He knew the country and what to do and how to do it. We think we should have been almost helpless without him. He knew how to take instructions and how to fulfill our purposes, and such information as he had of the country and of matters connected with this canal project was entirely at our disposal, and so far as I know he betrayed no secret, if a company can have secrets. He betrayed no secrets to my knowledge at all. His acceptance of service with us was in no sense improper.

Now, departing from that, we get down to the technical matters. Mr. Miller introduced testimony here before this committee which is of the first importance. I think it is the most important to the project that has been made by the gentlemen representing that side. He submitted here propositions from responsible men, contractors and others, who are prepared to do this work, and these statements were submitted in justification of the statements which have been repeatedly made by *the company that* those contractors stood by ready to do this work. I

wish we had had this information sooner, but we will investigate a little and see what it is and what it means. I have only rough notes, if you like, of what Mr. Miller said, and I will have to depend somewhat upon my recollection. I have not had access to his testimony, and I have not yet to my own, but I will go on with the material that I have been able to prepare with the assistance of my colleagues.

Mr. Miller submitted a proposition from Mr. Treat to construct the western division of this work for $31,000,000, and to guarantee results to the extent of digging it 28 feet deep from the Pacific Ocean to up here on the lake. There is a distinct and formal proposition of the first order of consideration. Mr. Treat is a person whose proposition must be treated with consideration. He is a man of repute and of success in his work, and what he proposes to do he proposes to do, knowing his own responsibility and prepared to back it. Now, what is the nature of this proposition? Mr. Treat's price for this whole canal on the western division is $31,000,000. That is submitted as a verification of the statement made by the company that contractors are prepared to accept the engineer's prices, quantities, and estimates.

It does not appear so, Mr. Chairman. The moment you look at these figures you find, instead of verifying the rather vague and somewhat uncertain propositions of the company, they, as a matter of fact, very distinctly and clearly vindicate and justify the unit prices and quantities adopted by the Board, and we are the more pleased to have it because that is absolutely the fact. The cost of the western division of the canal, according to the company's estimate of 1895, adds up $21,500,000 taking the low level line, disregarding the other, making a difference in that respect; but, taking the low level line, the company's estimate for the western division is $21,500,000, to which 20 per cent of contingencies is to be added, making a total equal to about $25,000,000. The Board's estimate for that same work is $28,000,000, to which is to be added 20 per cent for contingencies, and you get the result of $32,000,000. Mr. Treat's estimate is $31,000,000. It is approximately 50 per cent larger than the estimate of the company, and it is quite evident that Mr. Treat's unit of prices must have been somewhat larger than those which the Board adopted in its own preliminary estimate.

But there is another point back of this again, Mr. Chairman, which still further illustrates the importance of this proposition. Mr. Treat's proffer is made on the basis of quantities and prices of 1890. No estimate of 1895 had at that time been made. He had put in his hands, doubtless, the published report of the company for 1890, and that was his basis for estimating. Now, as a matter of fact, the company has varied very greatly this project between the dates of 1890 and 1895, and it has likewise varied its prices. Mr. Treat apparently was led to believe that he was working upon the latest project of the company, whereas, as a matter of fact, it had been materially modified, both by increasing the quantities and diminishing the unit prices.

Now, Mr. Treat's proposition to build the entire canal for $110,000,000 has to be discussed. I need only remark that in considering Mr. Treat's proposition to construct the entire canal for $100,000,000 this estimate is made generally upon the 1890 data, and he says that the borings on the east divide show solid rock. Now, that is a point about which, perhaps, it is very important to know. I may state, first, that with regard to the east divide the company had provided for a cut of only 80 feet wide at that time. The later proposition of 1895 is a cut of 100 feet wide, a very wise and judicious increase, but the results of that increase do not show. Mr. Treat is bidding upon a cut of 80 feet, and not of 100 feet. Furthermore, he is bidding upon a cut to be made in solid

rock, based, of course, upon the company's data and the company's statement that that was the material to be handled.

Now, I happen to have the report made by the geologist of the United States Geological Survey, addressed to the second vice-president of the company, dated June 19, 1891. Major Dutton had made an investigation of the geological conditions on the Isthmus with a view of ascertaining or reporting to the company whether or not volcanic or earthquake phenomena would imperil the construction of this work, and as to which he was able to report that, in his judgment, it would not. That judgment has been further confirmed by Professor Pittier, of Costa Rica, who came to the same conclusion, but Major Dutton was not satisfied with the investigation that he was able to make personally, and was not quite satisfied as to the real nature of the samples of rock which were shown him as having been taken from that east divide, and he therefore took means to have the samples submitted to a geologist in order to have the character more fully ascertained and examined under the microscope, and Mr. Iddings reports as follows:

DEPARTMENT OF THE INTERIOR,
UNITED STATES GEOLOGICAL SURVEY,
Washington, D. C., June 19, 1891.

Mr. GEORGE W. DAVIS,
Second Vice-President Nicaragua Canal Construction Company.

DEAR SIR: Your favor of 15th instant received, the specimens of rock submitted to me by Major Dutton have been made into thin sections and submitted to an examination under the microscope. They prove all to be volcanic material, more or less unaltered. Some are quite decomposed and soft. Major Dutton wished to know whether they would turn out to be massive blocks when excavated, or would form good-sized blocks. Of the eleven cores examined five are of compact, hard rock and six of decomposed and rather soft material. The accompanying memorandum gives the localities and name on profile, with the correct name appended.

In the interest of science I should be glad to examine a more extended collection of cores from different parts and depths of the proposed cutting, if accompanied by proper labels as to their locality, more especially from the deeper borings where the rocks are fresher.

Yours, very truly, JOSEPH P. IDDINGS, *Geologist.*

Colonel LUDLOW. Appended is a schedule which gives the characteristics of the rocks as determined by the geologist; and you will observe out of eleven samples received five are hard rock and six were decomposed and of rather soft material:

Label.	Name.
EAST DIVIDE.	
Boring at station 960+50, from depth of 159 to 160 feet 5 inches (called conglomerate).	Basalt: Compact and hard (like trap).
Boring at station 895+40, strata 31 feet thick (called talc).....	Andesite (pyroxene): Partly decomposed, soft and friable.
Boring at station 905+30, from depth of 70 to 86 feet (called trap and conglomerate).	Andesite (pyroxene): Partly altered, compact, moderately hard.
Boring at station 913+50, from outcrop to depth of 32 feet 6 inches (called talc).	Dacite: With many grains of quartz; compact, hard rock.
Boring at station 933+35, from depth of 44 to 84 feet (called talc and decomposed rock).	Dacite (altered): With grains of quartz; rather soft rock.
Boring at station 941+80, from depth of 38 to 86 feet (called talc).	Dacite: Decomposed and soft.
Boring at station 941+80, from depth of 86 to 222 feet (called conglomerate).	Dacite: Compact, rather hard.
Boring at station 960+50, from depth of 75 to 100 feet (called slate).	Basaltic ash: Soft, crumbling.
WEST DIVIDE.	
Boring No. 4 at station 243+32, from depth of 8 feet to 72 feet 6 inches (called conglomerate).	Andesitic ash: Hardened, compact and hard.
Boring C at station 306+88, from depth of 2 to 38 feet (called telpetate).	Andesitic ash: Altered, soft, crumbling.
Boring I at station 370, from depth of 54 feet 6 inches to 63 feet (called slate on profile).	Andesitic ash: Altered, soft, crumbling.

NOTE.—Dacite is much like quartz-porphyry. Andesite is one of the commonest kinds of volcanic rocks in the Rocky Mountains.

Colonel LUDLOW. The board had reason to believe, from an examination of the borings, that there was a good deal of material there which might involve very serious question when it came to opening that deep cut through the rock, and the board believed it was of vital importance that numerous borings should be made through that material, not only on the axis of the canal, but also adjacent to it and in the neighboring sides of it, in order to determine what would be the probable slope at which it would stand. These questions are of the first importance. These contractors' propositions are based simply upon the company's data without investigation.

I want to explain to the committee, if you please, the additions which have been made to this project, and what will be the consequent effect upon Mr. Treat's proposition if he had made up his figures on that basis. The amendment needed would be approximately as follows:

TREAT'S PROPOSITION FOR EASTERN DIVISION, AT LUMP SUM OF $31,000,000, TO PASS 28-FOOT SHIP.

This proposition is avowedly made on the basis of the project of 1890. The company's estimate for this project, excluding right-of-way indemnity and the Tipi-Tapa Canal, is $17,150,417; to which should be added a contingency allowance of $4,287,604, making a total of $21,438,021. Mr. Treat's lump-sum proposition is about $10,000,000 more, or about 45 per cent increase.

The company's project for 1895 calls for greatly increased quantities, which, if carried out at the 1890 prices, would amount to $25,072,272. Applying the same rate of increase to this amount, as applied by Mr. Treat to the amount of the estimate of 1890, viz, 45 per cent, the total would be $36,354,794, contingencies included. The estimate of the board for the same work, with the contingencies included, is $35,233,466, to which a small addition should be made for lights and buoys, making the total, however, less than that obtained by applying Mr. Treat's figures in the manner above noted. It is very clear, therefore, that Mr. Treat and the board must be assuming very nearly the same unit price. This would be expected, because the board adopted the unit price shown in the company's estimate of 1890, except the price for concrete, which the board increased considerably. On the other hand, Mr. Treat, while ostensibly using the same unit price, made numerous conditions, which practically amounted to an increase in unit prices.

The correspondence is not, however, quite as close as above indicated, because the board found it necessary to increase the quantities at Brito Harbor and at the locks, and to provide back filling and other items for the locks which the company had omitted, or had made insufficient estimates for, so that the unit prices adopted by the board must have been less than those used by Mr. Treat in arriving at his total of $31,000,000, for which he used the quantities furnished him by the company in their estimate of 1890.

Referring to Mr. Treat's proposition to build the entire canal for the lump sum of $100,000,000, it must be remembered that this applies to the project and to the quantities of 1890. It would need amendment to apply at the present time.

First. On account of the additions made to quantities in the company's revised project of 1895. This amounts, at the schedule of prices of 1890, which Mr. Treat undoubtedly refers to, to $14,100,000. If this were added to the amount of Mr. Treat's proposal, it would be $114,100,000.

Second. Further additions should be made to cover the errors in the company's calculations of amounts of excavation in the San Juan River and Lake Nicaragua, which, at the company's schedule of 1890, amount to $7,150,000. These additions would make Mr. Treat's proposal $121,250,000.

Third. If further allowance were made for a complete estimate for locks 80 feet in width, with the necessary back filling, concrete foundations, etc., for the increased height of embankments in the San Francisco Basin, and for an additional amount of excavation in the San Juan River and Lake Nicaragua to make channels of the width deemed necessary by the board, the total amount would be considerably in excess of the board's estimate. So that Mr. Treat's figures, instead of confirming the present estimate of the company, confirm, in fact, the estimate of the board.

Colonel LUDLOW. Now, with reference to Mr. McDonald's proposition, who made a bid for the construction of this canal for $70,000,000. I have not the figures before me, and they are subject to correction, but I believe it is $70,000,000.

This is also based upon the company's quantities of 1890, which have been largely increased in the project of 1895, and require still further increase to constitute an adequate project, in the opinion of the board. His unit prices are, in most cases, higher than those of the board; notably, the price of $1.80 per cubic yard for rock excavation, $2.40 for earth under water (understood to apply to lock excavation), and $10 per cubic yard for concrete. If these prices were applied to the board's quantities the total would exceed, it is believed, the board's estimate. Mr. McDonald's price for earth excavation—50 cents per cubic yard—is a little less than that adopted by the board, but if the price of $2.40 per cubic yard applies to lock excavation, then Mr. McDonald's average price for earth excavation is undoubtedly larger than that of the board. But, as a whole, the figures confirm in a remarkable way the board's unit prices.

It appears from the above that the propositions read by Mr. Miller confirm the correctness of the board's unit prices, and that if there is any material difference, the board's prices are lower. It must be remembered that the lump-sum bids are on the basis of the company's estimates or quantities in their report of 1890, that they have themselves since largely increased the quantities, and that a further increase is still necessary.

Now, as to Mr. Bower's proposition for dredging. His proposition, of course, is on the basis of 1890 data.

BOWER'S PROPOSAL FOR DREDGING.

Bower's hydraulic dredge is a pump dredge, and its use would be impracticable in stiff clay, heavy gravel, and bowlders. In the canal section near Greytown it would be necessary to remove the surface stumps, logs, etc., with some other plant before employing this.

Miller states that the actual cost of dredging at the Panama Canal was from 40 to 60 cents per cubic yard, and was half profit. If we take the net cost at 20 to 30 cents, and add 20 per cent for profit, the figures will agree fairly well with those of the board.

The company's quantities of 1895, at the prices of 1890, would make a total of $78,000,000.

The board's quantities, at the company's schedule of 1890, would amount to $117,000,000.

[Bennett noted a variation in the river at Ochoa of 14 feet 4 inches in the first three months of 1888. This is pertinent in view of what Miller said about the filling up, or backing up, or foot of rapids.]

With further reference to one or two points in Mr. Miller's testimony, it is characteristic that whenever further consideration is given to the company's project it has an aptitude for varying. Mr. Miller put in two new propositions in the company's project in his last statement. He stated, first, that the weirs in the Ochoa Dam were "of course" to be movable weirs. Well, the board has contended in its report that unless movable weirs were used, or sluices, or the equivalent of them, it would be impossible to restrain the excessive rise of the lake in the wet season or to hold up the lake to its proposed summit level during the dry season; but, if you please, the canal project not at any time or in any way or in any place, so far as we are aware, and we have gone pretty thoroughly into the subject, has ever suggested that the weirs to be used on the top of the Ochoa Dam, or the weirs to be used in the San Carlos ridge, which is practically a continuation and an essential feature of that dam, or any other weirs through which or by which, directly or indirectly, the discharge of the surplus water was to be provided for, were to be movable weirs. There is not the first hint or suggestion to that effect, and we are pleased to see a corroboration of our own opinion in that respect by Mr. Miller's expression of belief that some such provision will be required. And there I might say en passant if that be done it will require a very considerable increase of the company's estimate of cost for that work.

The estimate is based upon an absolutely fixed weir without anything moveable in it, and the construction of these moveable weirs of the *dimensions which* will be required in such case will amount to a formi-

dable sum of money. The other novel proposition of Mr. Miller, novel in the literature of the company, was that before anything should be done really, notwithstanding the acceptance and completion and perfection of this project, before anything should be done, a board of consulting engineers should sit on the matter and that they should be paid large salaries, and that their judgment with regard to technical matters of this kind would unquestionably be followed by the company.

Mr. DOOLITTLE. Let me interrupt you and ask if anything was said in Mr. Miller's statement about large salaries being paid?

Colonel LUDLOW. If I am not extremely mistaken, there was something said.

Mr. DOOLITTLE. I think the notes will show he did not say anything with regard to salaries whatever, and when he spoke of the employment of consulting engineers it was relative to those very important places which have been dwelt on by the board at Ochoa, and also over on the Brito side of the lake.

Colonel LUDLOW. I think Mr. Miller's own notes will show, and I do not pretend to any more than ordinary accuracy of recollection of things, but I listened to Mr. Miller's testimony with great interest naturally, and I am quite satisfied he made some such remarks.

Mr. DOOLITTLE. However, I do not think that is a matter of considerable importance.

Colonel LUDLOW. Then why not let it go without interruption?

Mr. DOOLITTLE. Well, I thought it was of sufficient importance, of course, to call your attention to my understanding of the fact that he did not mention salaries.

Colonel LUDLOW. The stenographer's notes will show. I think, Mr. Chairman, if it would not be too much trouble for the stenographer, he might settle the matter at once.

The CHAIRMAN. It would take time to do that.

Colonel LUDLOW. Very well. I have no disposition to take up the time of the committee. It is only this point that I want to make—the question of salaries is nothing—that a board of consulting engineers, if you please, have had this project under consideration, and within the last year. It was true that those engineers were not appointed by the company and did not receive their instructions from the company. They were appointed by the Government of the United States and received their instructions from the Congress of the United States. That fact probably does not deprive the consideration of this subject by that board of weight, nor does it constitute any imputation against the thoroughness of their consideration or value of their conclusions. It seems that for some reason the company, notwithstanding its expressed willingness to accept the suggestions from a board of engineers of that character, distinctly repudiates them and objects seriously to the board having made them. It may be if we had been content or had had no objection to accept just such data as the company should furnish that we should have found ourselves in the same predicament as the Bogart board, which, as I quoted the other day, stated as a formal part of its report that the locks proposed by the company as shown by the borings were founded on rock. The company does not make that contention to-day, and no examination of the borings can have any other effect than to refute it.

It might be interesting to inquire what borings these were which were submitted to this Bogart board in New York and upon which they make the statement that the borings submitted to them showed the locks to be founded on rock. As to this project, it is fair to say, Mr.

Chairman, with all the various changes and protean aspects it has assumed from time to time, I think in view of the light that has been thrown upon the matter here the committee can perhaps understand the extreme difficulty of our task of last year in trying to ascertain definitely what it was the company proposed to do and how they proposed to do it. I think the committee will appreciate the difficulty of our task and perhaps later, when they do us the honor of examining our report, they will give us due credit, also, for the temperateness and the seriousness with which we sought to consider the subject, to consider all these questions in all their bearings and aspects, and with an entirely favorable opinion and intention with regard to the construction of a canal across that isthmus to get the thing in such shape that we could report it as feasible and fix some probable sum within which it could be completed.

We had to take the project which they had and modify it and correct it. We had laboriously to ascertain from other sources than the company what might be the facts really of the case. We ascertained much for ourselves and we got more from others, and using all the information that we got from every quarter we made such modifications in the project, such increases, and such additions to the unit prices and quantities and such changes of the structure and methods of construction as we thought to be judicious, and we finally succeeded in getting it into such shape that we were prepared to report it was a feasible project and we believed it could be done within a certain sum of money.

The CHAIRMAN. Right there let me ask you. State what expression was made by the board at the time of leaving Nicaragua, or about that time, to the effect that this project was not a feasible one and the canal could not be built.

Colonel LUDLOW. Well, sir, I think quite likely——

The CHAIRMAN. If some conclusion of that kind was arrived at, please state it.

Colonel LUDLOW. Well, an opinion; hardly a judgment. You see it was this way, Mr. Chairman. We had read and assiduously studied this canal literature. We had in our hands the report of the chief engineer of 1890. We had his still more important paper, formally prepared for the World's Columbian Engineering Congress of 1893. We had other statements, and there is a statement here which I desire to incorporate as a portion of the material, and I shall read from the executive document of the Fifty-first Congress, second session, which is a report of the Maritime Canal Company to the Secretary of the Interior, the accuracy of which is attested under oath by the president and secretary of the company. This material naturally must receive consideration. We find—

> That the final plans and the detail surveys of the canal and its harbors, locks, and other accessory works have been completed and verified, and no efforts have been spared in perfecting the route from ocean to ocean.

That is the statement. We find the statement in the report of 1890 that every problem had been solved.

> That the surveying parties of the company had gathered such a mass of valuable information as to leave no doubt whatever regarding its superiority and the amount and character of all the work involved in the construction of the canal. No problem has been left unsolved, and what is now presented as the result of these arduous labors is an actual representation of the actual conditions.

This is the report of 1890.

Mr. PATTERSON. Of whom?

Colonel LUDLOW. Of the chief engineer of the company, sir. That

is our text-book with which we went down, and we reached the country studying it attentively. We took the chief engineer's formal statement before the engineering congress, expressly prepared for the information of the world, as to the real nature and essence of this project. No one could believe when the paper was prepared that it could be anything else, at any rate up to that date at least, than the convictions of the writer as to the verity of everything in it, and without going into any details of statements, one of which was brought up yesterday as to the state of Ochoa Dam, we found statements like this:

It was originally planned that some sections of the canal in earth should be 80 feet in bottom width, with side slopes of 1½ to 1, and in the rock cuts with vertical sides. This would accommodate the traffic for several years; and then the areas in cross section could be increased out of the earnings, as at Suez, but at a greater ultimate cost.

Following that is this statement:

It has been decided to make provision in the designs for the ultimate requirements; and the following table shows the length of the different sections of the canal in excavation in the lake, the river San Juan, and through the basins, and also the dimensions of the prism for the same as now proposed.

Then follows a schedule very much increasing the section in many respects of the report of 1890. For example, the least width at any point or the narrowest point is 100 feet through the divide cuts, and the next narrowest is 120 feet, and so to the river with 125 feet, and to the lake with 150 feet. We had this information before us, and we had not the least doubt in the world it was all right, and arriving in Nicaragua we were confronted with a condition of affairs which was quite other than that which we had believed existed. We came to look into things, and we found there were many problems of the first magnitude which had not been solved, and for which no means whatever had been prepared for solving. Hydraulic data were lacking and borings were insufficient; foundations had not been explored. We found Lock No. 3 had been moved between 1890 and 1895 to a new site and the site has never been bored. We found mud bottoms in the San Francisco Basin where these great dams go that had never been bored and their depth was not known. We found the San Juan River had never been surveyed so far as to ascertain what was the real nature of the material to be taken out, and so on.

I admit that when we returned from this investigation and found the company declaring that the lake would vary 4 or 5 feet and the river to correspond, that no floods were to be apprehended, when we ourselves could read on the banks of the river as we went along and at points where we stopped and made levels to determine that the actual rise and fall might be as much as 12 or 14 feet, and at one point as much as 20 feet, I must say that we were disconcerted with the situation, and we found it at variance with the situation as it had been presented to us in the former publications of the company. It might well be on returning to Greytown that we should feel discouraged. I know I did. Furthermore, we found that the entrance to Greytown Harbor, whether by virtue of careless engineering or by virtue of adherence to the terms of the concession, which should strictly limit the location within which the entrance should be constructed, we found, as we believed, a construction of that entrance at that point would be practically impossible. It was extremely injudicious to undertake it.

We found over at Brito Harbor the investigation there had been entirely inadequate and nothing like a full determination of the work to be done in the construction of the harbor at that point, a most for-

midable point, as much so, perhaps, as in all the history of our American engineering we have ever seriously attempted building a harbor. It is a level shore, and the Pacific comes in with a surf that in the calmest weather is from 4 to 10 feet high. What will be the situation when you have one of the westerly storms or a southwesterly storm we could not realize; but we did realize that the endeavor to make a harbor at that point in conflict with what might be the natural forces was something that should not be lightly entered upon, and we did not in the least believe that the proposition of the company was in any sense adequate.

We were discouraged when we got back to Greytown, Mr. Chairman, and we sought means to refresh ourselves. We looked at other points, and secured encouragement from the work done at Costa Rica and from the work done at Panama, and we did derive encouragement from that, and we still had confidence that, after all, when we got back to New York and had a chance to explore the great mass of the company's data which had accumulated there for many years we should be able to feel that in some way, even if not from memory and from conversation, we would be able to get the information we wanted, and we spent the three months of the summer in exploring that question from every possible point of view. Well, after a while we got a more encouraging view of it, that is true, but I can only say now as to what our view was in Greytown. If we said anything on the subject we could have said then the project of the company as a project was not feasible, nor will any one declare it is.

The project of 1890, which was then the project of the company, it is admitted is not feasible by the improvements and necessary alterations that the company itself has since made in it. The project of 1895 was not formulated until we requested that it be done, in view of the changes which had been suggested and indicated and the necessary additions or alterations of the estimate which must ensue. The one thing we found absolutely fixed was the total cost of the canal across the Isthmus; and while every feature of it might vary—the route and the construction, whether a masonry dam or a rock fill dam, whether weirs, sluices, or locks, of different width—there was one thing only that was fixed. We found the locks varied. In 1890 we find them 70 feet; in 1893, according to the chief engineer, they were 80 feet. We went back and found that the price for a lock 80 feet wide was absolutely the same as one 70 feet wide. These locks varied so often that you would have to go to a rubber manufactory to get them built, and other things had an equally elastic tendency; and you yourselves, gentlemen, have seen the facility with which the Ochoa Dam can be varied in its dimensions and cost. We were puzzled with a dam which in 1890 cost $720,000 and in 1895 cost $970,000, and you saw yourselves yesterday from the testimony of the chief engineer how the price may vary with great rapidity from $1,000,000 to $3,000,000 and not leave a clear impression upon the mind of the hearer as to what figure was fixed as the view of the company of the cost of that most vital piece of work.

The CHAIRMAN. Was there any expression of the board that the general Nicaragua Canal route was impracticable?

Colonel LUDLOW. No; I judge not. I do not think any of us felt that. I can only speak for myself, but I do not think any of us felt that. I know I did not. When a man asked me, I rather jestingly told him, "If you wait ten years you will see ships going by here." He endeavored to consult me professionally. He had a holding there and he wanted to know whether to sell or to keep it. Now, these estimates I

will simply read off, and it will not take two minutes, and yet they are very instructive. In 1873 the estimate of the Lull Expedition was $65,750,000. In 1885 Mr. Menocal's estimate was $64,000,000. In the company's estimate of 1890 it is $65,000,000, and in the company's estimate of 1895, according to their cheapest plan of the Tola Dam, it is $66,750,000. The average price of that is $65,000,000, and the largest departure from it is under a million, the projects themselves varying very widely indeed. In 1885 it was to be a masonry dam at Ochoa on arches on a sand foundation, and I have seen the proposed method of constructing the masonry dam with arches in the report of the chief engineer, stating that the foundations were to be put 20 feet below the surface of the water, and the water in one corner of the river was 16 feet deep. That would have left for a masonry dam a foundation of only 4 feet in sand and with a river to be raised 60 feet high.

As to what would happen to the dam holding water up under these conditions, we did not care to investigate. That dam was dropped in the report of 1890, and a rock-filled dam was the project; with water running over it. Of course, these changes year by year or season by season involve large changes of quantities, and how is it that with all these changes of quantities there is no change in the total, or next to none? It is brought about by the extremely simple method that if you have 25 per cent or 50 per cent more work to do and will simply slice off the unit price sufficiently, you will have the same total cost you had before, and it is quite evident by a continuation of that process you can get down to a sea-level canal across that isthmus at the same cost if you simply go on and make a reduction of the unit prices to meet the increase of quantities.

Well, I happen to have here one of the appendixes of the report, which is a small matter, perhaps, if you like, but it is significant. It is a summary of the water-gauge readings that in the course of the company's investigations were made there, and we found at Camp Carazo, San Francisco Island, a short distance below the Ochoa Dam, there were watermarks taken which indicated a range of 12.85 feet at that point, and at Ochoa Dam, the very point in question, there is a record of 14.4 feet, and the observations were made by Mr. Bennett, of the company. Mr. Bennett is a very excellent and, in his way, capable and thoroughly honest fellow. He was with us all through in charge of the drawings and we got very much information from him. It was from him, if I am not very much in error, we got the information that just before the close of work down there the company had commenced a new line of levels from Greytown to Ochoa for the purpose of determining a discrepancy or uncertainty of 1 foot in the recorded levels as they existed in the company's compilation. The chief engineer said yesterday he did not know of that, but if not, who ordered the resurveying?

I think I want to refer to one other matter—there are many others, but I do not wish to delay the committee, and it is impossible to treat them all. This question of the Suez Canal and its dimensions has been referred to, and the Suez Canal is the only work in the world with which this canal is properly comparable. They are both strictly interoceanic. The Manchester Canal, a very great work, is merely an inland connection of Manchester with the sea. The Kiel Canal, the German canal, is only a connection of two of those shallow oceans and is intended for the use of such vessels as navigate those seas, not of very great dimensions, mostly for the passing of the German navy from one side to another, and the German naval ships in their construction and dimen-

sions are also adapted to the seas they navigate—the Baltic and the German Ocean.

Mr. BENNETT. Is the summit level of the Suez Canal the summit level of the Mediterranean?

Colonel LUDLOW. It is sea level right through from the Mediterranean to the Red Sea. There is no gate or lock in it. The Mediterranean tide is about the same as the Caribbean tide—about a foot—not great. The Red Sea tide varies somewhat; it is a closed sea and subject largely to the influences of the winds.

Mr. BENNETT. Is the Kiel Canal a sea-level canal?

Colonel LUDLOW. It is a lock canal, but it is a sea-level canal in one sense; and they introduced locks for the reason the Baltic has no tide, whereas the German ocean, into which the other end debouches near the mouth of the Elbe, has a considerable tide—as much as 9 feet—so, being a short canal, if they left it entirely open without gates and locks there would be danger at times of a tremendous current pouring through it, owing to the uniformity of the level of the Baltic and the greater variations at the Elbe end. I may say in that connection that if this Nicaragua Canal is to be compared with any sea canal, it is absolutely necessary to nail fast in some way that oscillating and elusive summit level, for if that summit level is permitted to oscillate the canal will cease to be comparable with any other work of that character in the world that is either built or contemplated. These other canals all have a regimen, they have a summit level which is maintained within in a measurement of inches. The statements and suggestions of the dimensions of the Suez Canal in all the company's literature are incorrect, and I may say the same of the statement made by the chief engineer with regard to it yesterday.

Mr. BENNETT. Is the level of the Atlantic Ocean at Isthmus the same as the level of the Pacific Ocean?

Colonel LUDLOW. Just the same. That is inevitable, it must be so.

Mr. BENNETT. That is what I imagined, but I understood it was somewhat different.

Colonel LUDLOW. It is a very interesting fact, if you please, not to detain the committee, that whenever there has been any attempt to connect two seas there is always that question raised of a tremendous difference between the level of one sea and the other, and it is curious it should have been so. We used to be told that there was a difference in level of 7, 8, or 9 feet between the Atlantic and the Pacific. Inasmuch as they are free oceans they must be the same level. Gravity would bring that about necessarily. And it must be the same with any other. It is the same with the Red and the Mediterranean seas, because they had a connection outside the continents and variations will only be local.

In the nature of things, the mean level must be the same the world over. Gravity arranges that. Yet Napoleon's engineer, when he was ordered by Bonaparte during the occupation of Egypt to investigate that problem of the Suez Canal, made the decided error of determining there was a difference of 25 feet, and the same error had been made long before by the Greeks. The same accusation was made against the small but astonishingly interesting canal, the Corinth, which is quite important, and it had that same history that there was great objection to cutting that little neck of land off because people living on the one side feared the sea was going to pour through and wash them out, and yet they are only about 280 or 300 miles apart, measured around the isthmus. The original design of the Suez Canal was with a bottom

width of 40 meters, about 125 feet, and to be 8 meters deep, if I am not mistaken, although the information is a little obscure on that point, and the original final estimate of the Suez Canal was based on a cost of $40,000,000, or 200,000,000 francs. They reduced the dimensions afterwards in order to get it completed, and finally, at a cost of $110,000,000 (550,000,000 francs), they succeeded in constructing it as it was opened for use with a bottom width of 72 feet, and, in order to enable vessels to pass, sidings or excavations were cut in the banks where one vessel would enter while the other would pass.

They found that condition of things incompatible with due facilities for transit, owing to the increase in the number of vessels passing through, so that the widening was begun, and has now been nearly completed, except for 9 or 10 miles, so that the Suez has a width of 37 meters on the bottom, or 121 feet, and the least depth of the Suez Canal which it has been found advantageous to leave at all is 8½ meters, or 27.1 feet, and for the greater part of the length of the canal it is 9 meters, or 29 feet 6 inches, say, in round numbers. The average time of transit is twenty hours, and the average number of vessels is about ten a day. Now, all but about 9 or 10 miles of the canal has been widened to the width of 121 feet on the bottom, and a formal plan has been drafted and submitted to the canal administration in Paris, and has been approved by them, although not yet ordered, because they are not prepared to go on, increasing the bottom width of the canal in the straight portions to 66 meters, or 210 or 215 feet, and on the curves to 80 meters in width.

The reason for that is simply this, that notwithstanding a bottom width of 120 feet, the vessels are not permitted to pass each other in the canal at speed. Their speed is limited to 10 kilometers, or about 6 miles, an hour, and they are not permitted to pass under way, notwithstanding this increased dimension of 120 feet. When two vessels meet, one or the other, according to an arbitrary arrangement, goes to the bank and the other goes by, and this increased widening there is believed by the company to be necessary to permit vessels to pass each other freely and without any delay at all.

I had some other notes here, Mr. Chairman, but I think there are only one or two other points I care to refer to. I made the statement on the authority of Mr. Davis that certain portions of the canal route, or an important part, Mr. Menocal had not seen, and I believed it to be true, and yesterday Mr. Menocal made a statement with regard to it, but he omitted to say, however, whether or not that is true, or whether or not there is still a portion of that canal line—either the axis of the canal or of the embankment line, which, wherever there is an embankment is more important than the canal line—that since its final adoption he has not inspected. If he cares to answer that question categorically, I will be glad for him to make a reply to it. I would also be incidentally glad to know categorically whether or not he has ever himself personally gone over the line of the San Carlos ridge, which, you understand, is practically a continuation of this Ochoa Dam here 10 or 12 miles, where waste weirs and sluices are to be built, and the constructions are important. We went over that route ourselves on foot, but I have an impression that Mr. Menocal has not.

I want to say, Mr. Chairman, we have had a most formidable task here. We supposed our relation to all this matter was closed with the rendition of our report, and we suddenly found ourselves challenged and attacked on the floor of this committee room before the public, in the newspapers, and everywhere with imputations upon our conduct,

discretion, and capacity, and intended for no other purpose than to invalidate our conclusions as expressed in our report. You will understand the difficulty of meeting suddenly and unexpectedly an issue of that kind in an enterprise of this magnitude and invested with most formidable aspects. Great interests are arrayed on one side and the other, and great personages, you might almost say, have been taking active part in it, and if there has been anything that is lacking in our presentation of the matter by myself and my colleagues I beg you to believe we have at least done our best and given the committee such information as we had, and endeavored to tell you clearly what we believed to be true, and, with such proof as we had to present, that it was true.

On behalf of myself and my colleagues I have to thank the committee for the continuing courtesy and consideration, without which, in so difficult a matter as oral testimony on a project of this magnitude, and with so many details in it of quantities and figures, that task would have been simply impossible, and I beg in behalf of the Board to tender our thanks to the committee for their consideration in that regard.

The CHAIRMAN. There is a question I want to ask you in regard to the summit level of the lake. Suppose the company adopts 110 feet as that level, and that the whole canal structure is constructed with that fact in view. Suppose that the mean height of the water of the lake is 110 feet?

Colonel LUDLOW. The mean level?

The CHAIRMAN. Now, what will be the effect upon the structure if there should be a variation of, say, 18 inches, or 2 feet or 3 feet below that mean height?

Mr. PATTERSON. Or above it?

Colonel LUDLOW. Any reduction from the summit level, whether it be fixed or varying or stated as a mean, any reduction in depth below that summit level, as depths are measured, would of necessity to exactly the same amount reduce the depth of navigation.

The CHAIRMAN. Then, on the supposition the canal project is constructed upon the basis of 28 feet of water relative to 110 feet as the mean height of the surface of the lake, if there should be a reduction of 3 feet in the level of the lake, namely, to 107 feet, the capacity of the canal would only be adapted to a 25-foot vessel; would that be the result?

Colonel LUDLOW. With a reduction of 2 feet?

The CHAIRMAN. Of 3 feet.

Colonel LUDLOW. Oh, no, sir.

The CHAIRMAN. If it falls to 107 feet in the lake, and being constructed with a view to 28 feet on a basis of 110-foot level?

Colonel LUDLOW. With a channel of 28-foot depth the deepest vessel you would be likely to get through that channel would be not over about 26 feet. In the Suez Canal, with a soft bottom, they are not permitted to draw within 2 feet 3 inches of the depth; she must unload if she draws more than that.

Mr. PATTERSON. That is not the question. What the Chairman, as I understand, wants to get at is this, that whatever the reduction shows in the summit level that there is a corresponding reduction in the canal elsewhere?

Colonel LUDLOW. Of course, because your allowance underneath the keel of the vessel is a fixed quantity, and, therefore, whatever reduction you make in the summit level that much is cut off the draft of a vessel you permit to go through.

Mr. CORLISS. Would a reduction of the summit level of the lake affect to the same extent the canal its entire length?

Colonel LUDLOW. Well, the lake and the river.

The CHAIRMAN. It would affect every part above the Ochoa Dam?

Colonel LUDLOW. They are all part of the summit level. It runs through the east divide on one side, and through the west divide on the other.

Mr. PATTERSON. I understood you in your remarks to-day to say it was absolutely necessary to maintain the summit level. Now, I did not exactly gather your meaning there. Do you mean to say that if the canal is 28 feet deep, in order to float a vessel drawing 26 feet it must retain the 28-foot depth, and any reduction in the summit level would affect the navigation of a ship drawing 26 feet of water?

Colonel LUDLOW. Crowd out all those ships.

Mr. PATTERSON. Now, is that your meaning, or is there some other reason?

Colonel LUDLOW. No; it is a commercial meaning in that respect, just a mere matter of building some kind of a waterway there. The variation would not amount to anything if you did not care anything about your depth.

Mr. PATTERSON. So if there was a summit level of 110 feet and a depth of 40 feet in the canal the summit level might go down 5 or 10 feet and not affect the navigation?

Colonel LUDLOW. No; because you still have water enough to float your ship.

Mr. PATTERSON. I understand it.

Colonel LUDLOW. If it is going to be a 28-foot navigation, it must be such at all times and all seasons, so as to permit a 26-foot ship to go through. If we had a 30-foot navigation, then at all times and all seasons the arrangement should be so a 28-foot vessel could go through, or else you destroy the integrity of the navigation.

Mr. PATTERSON. When you say the integrity of the summit level must be maintained——

Colonel LUDLOW. It must be maintained at least at a minimum. The idea of our supposing it must be maintained like a cast-iron surface, at the same height, going neither above nor below, is, of course, out of the question. We have to assume that the minimum summit level must be maintained, or otherwise the 28-foot navigation would cease to be there, and that is a matter of how much that lake is going to oscillate.

Mr. PATTERSON. There is one other point——

The CHAIRMAN. Before you leave this point. The Ochoa Dam is designed with a view of maintaining a 110-foot summit level?

Colonel LUDLOW. In the lake.

The CHAIRMAN. Now, suppose that to be the mean, what reason have you to believe that there will be a minimum below that, and what is the extent of that minimum, if there is any?

Colonel LUDLOW. Well, sir, that is just one of the problems we did not have the means of solving, and it is absolutely vital to the project. The range and oscillation of the lake have never been observed by anybody. All the evidence we could get on that subject simply indicates that sometimes the lake was so, and sometimes it was so, and sometimes it was so. We measured everywhere we could get a watermark, or an indication, at the Granada wharf and at the San Jorge wharf.

Mr. BENNETT. What was the greatest variation?

Colonel LUDLOW. We found reason to believe the lake has varied as

much as 14 feet, measuring from the lowest point we could hear of up to the highest point we could hear of, reliably.

The CHAIRMAN. When you speak of 110 feet being the summit level there, at what season do you understand that was ascertained? In the flood season or in the dry season?

Colonel LUDLOW. If you please, the summit level is to be adopted as a datum; it does not exist as a natural phenomenon at all. The lake at what is mean average low level in ordinary conditions perhaps is at about 102 or so.

Mr. CORLISS. That is under natural conditions?

Colonel LUDLOW. Under natural conditions, just as you will find it, and it is quite in a state of nature. There is no artificial construction there of any kind. If you establish the summit level at 110 you will have to dam the water until it will never fall below 110, it becomes an artificial surface, or at least a surface artificially maintained, and in its natural condition it ranges below that and undoubtedly has ranged above it. The idea which I have had in the matter is this: When the Ochoa Dam was constructed——

Mr. PATTERSON. It would be constructed with a view of maintaining the summit level at 110 feet?

Colonel LUDLOW. It is so stated, definitely and distinctly, in the company's reports.

Mr. PATTERSON. Now, if the lake should rise 14 feet, or any number of feet, why, this surplus, which raises the level of the lake above that mean level established by the dam, would find an escape through these weirs and over that ridge and into the Atlantic?

Colonel LUDLOW. That is 70 miles away.

Mr. PATTERSON. Whereas it could not fall below the 110 feet afterwards, because the dam fixes and establishes it at 110?

Colonel LUDLOW. You can not do it. The dam itself, according to the company, is only 105 feet. The dam is to be built to 106 feet, and, according to the company's project, is to be used as a weir. In other words, water is to pour over it, and the sill of the weir is established by the company's project at 105 feet.

Mr. PATTERSON. That means a mean level of 105 feet?

Colonel LUDLOW. That means the point at which the water escapes over the Ochoa Dam is at a level of 105 feet, and it is assumed by that arrangement in connection with other arrangements it will maintain the water level in the vicinity of Ochoa Dam at 106 feet. In other words, between the sill of the weirs and the surface of the water there will be a depth of 1 foot of water always pouring over it, and that arrangement will lead to a fixed slope of 4 feet upward, and that arrangement will hold the lake at 110 feet. Of course, we found that incredible.

The CHAIRMAN. Suppose that condition to exist—that the actual slope of the river as created by this dam would be 4 feet. Now, then, suppose that the lake rises 14 feet above that and that the slope of the river is increased from 4 feet to 18 feet; what effect would that accelerated current have upon the navigation of the river by boats upward?

Colonel LUDLOW. If such a condition could exist, Mr. Chairman, it would be quite impossible to get a boat up this slope.

The CHAIRMAN. Could that condition exist?

Colonel LUDLOW. I do not believe it could, because this variation we observed of 14 feet of course is obtained by comparing what was at one time the highest and at some other time the lowest.

The CHAIRMAN. But if by correction through the Ochoa Dam you make the minimum 110 of the level of the lake, then the fluctuation must *be upward*?

Colonel LUDLOW. The fluctuation will be from that level up, and it is a question of what it will amount to. It will not amount to as much as we found in the natural condition because the river will have a larger channel and a much greater area to discharge through and will commence doing so sooner, and there will be no longer 14 feet; but say it be 4 feet or 5 feet, we do not know, we have not the means of ascertaining that. It might be 6 feet.

The CHAIRMAN. Suppose it could be so, what would be the probable increase in velocity if you double the slope of the river from 4 to 8 feet; what would be the corresponding increase in the velocity?

Colonel LUDLOW. It may be four times or more, dependent somewhat upon the banks and other conditions. It makes a very complicated thing to work out.

Mr. JOY. What was the level of the lake when you were there; did you determine that?

Colonel LUDLOW. Yes; we noted that, and it is in the report. It was 101.8, Mr. Endicott reminds me.

Mr. BENNETT. Using the Ochoa Dam as a weir for every foot of that minimum, there must be 1 foot more dredging done on the river?

Colonel LUDLOW. Absolutely; if you desire a deeper stream in order to maintain navigation you will have to deepen it.

Mr. BENNETT. Has any provision been made for overflow into the Pacific from the lake?

Colonel LUDLOW. No; none whatever.

Mr. BENNETT. Could such a provision be made?

Colonel LUDLOW. Yes; but it is not wise to use a canal for drainage. You do not want any current in a canal if you can help it. You have a narrow cut to go through rock, and any current increases the difficulty in getting through.

Mr. BENNETT. It would be much less distance from the lake to the Pacific Ocean?

Colonel LUDLOW. Yes; you could get rid of it more quickly there, but if you undertake to do that you would have to make some special provision for it. It would not in the wide world do to pass it through the canal. There is danger in a narrow rock cut, and they are only 100 feet wide, the cross section being only 3,000 square feet, and if you undertake to take any great body of water through that cut you will have such a current you will not be able to use it for ships. Now, in direct connection with Mr. Bennett's statement. It is quite likely in these long, narrow channels, 100 feet wide and 30 feet deep, it will not be found practicable to move a large vessel faster than about 3 miles an hour. Suppose you have a current of 3 miles an hour in there, and you undertake to take a vessel against it; of course she is stationary, and that ends it. I merely use that as an illustration of the difficulty of undertaking to make a mere drainage of a canal.

Mr. PATTERSON. Mr. Menocal stated on yesterday that in the borings at Ochoa Dam they went at least to the depth of about 28 feet, or whatever it was, and that the borings showed that the bottom was sand and that they had not gone sufficiently far to find a rock bottom?

Colonel LUDLOW. No, the borings ended in sand.

Mr. PATTERSON. He stated they might find rock below that, but they had not found it. Now, suppose that this dam is constructed on sand in the bottom of that river. Is that such a foundation as would make that dam unreliable and untrustworthy for holding such a large volume of water?

Colonel LUDLOW. Well, sir, it is well known in engineering matters

that a sand foundation is an extremely undesirable thing to have to deal with. It has been dealt with, and successfully, but by special provision for doing it. You can have worse than that—you can have soft mud, if you like. Sand has a certain kind of solidity. In its essence it is hard and compact, and sand, if confined so as not to escape—if it could be cased up or boxed—then sand to build on is much better. It is quite incompressible, but the action upon loose sand by anything like a thread or current of water is a very dangerous thing to introduce. The sand will flow with the water, and if the sand be small enough it will go through small interstices; so a sand base for a dam is extremely undesirable if you can find any other.

The barrage that crosses the Nile below Cairo is built in the Nile delta and rests as a matter of fact upon sand and mud which compose the bottom of the river at that point, but extraordinary precautions were taken and the French engineers failed in making the work a successful one. It was a very formidable task, and they presently abandoned it, and it was later taken up and finally completed and put in its present perfected form by English engineers. It is masonry work which practically is almost without a foundation. They made a very extensive riprapping of stone to cover the bottom. There is no excessive current, because the dam itself intercepts that.

The height to which the water is raised by the use of this dam, which was put in in order to provide for the irrigation of a large portion of the delta, is only, if I remember, a matter of about 9 or 10 feet, so that the head of water was not formidable; but here is a head of 60, 80, or 90 feet, and what are you going to do under those circumstances? If you can find rock there, even at 50 feet, it would be a great encouragement to an engineer who had to design a dam at that point. If, however, as we are informed in this case, you have nothing to do but to build it on the sand, why you must build on the sand or go without your dam; and if that dam must be built, why build it or let the project go.

Mr. PATTERSON. Do you think it is practicable to do that on the sand?

Colonel LUDLOW. I think it is practicable, sir; but you observe that the defects of the foundation in that case can only be amended, as it were; your conditions can not be altered, and you have to make up for the deficiency in your foundation by a necessary increase in the magnitude and weight of your structure. There is no other way.

Mr. DOOLITTLE. A question just at that point before you go to a new line of thought. You believe with the proper material and time you can construct a dam there that would hold the water all right?

Colonel LUDLOW. We finally came to the conclusion it would be practicable, although it has never been done. The work is without precedent in engineering construction.

Mr. PATTERSON. You spoke of the harbor at Brito. Now, just judging from the map which stretches across the room here, it seems the shore line there is tolerably straight. Now, what is the method of construction of that harbor? You say the surf there often on calm days rises from 4 to 10 feet, and in a storm I suppose the ocean there is very violent and deep?

Colonel LUDLOW. It deepens off rapidly, the shore deepens off rapidly.

Mr. PATTERSON. What is the idea of constructing the harbor there at Brito?

Colonel LUDLOW. How to do it?

Mr. PATTERSON. How do they propose to protect the ships there *against the gales* in that locality?

Colonel LUDLOW. Well, in a very imperfect way. That map there, however, is not designed as an engineering map.

Mr. PATTERSON. Well, just explain it as well as you can.

Colonel LUDLOW. Off here, observe, is a little red block [illustrating] on the left-hand side. Here is a little, rocky promontory extending out into the Pacific just here [illustrating]. The harbor is to be made here, underneath that promontory and in connection with it. That extends out, maybe, a quarter of a mile into the sea, a couple of hundred feet high, and the company proposes, properly, to make a breakwater which shall extend from the end of that promontory crosswise so as partly to intercept the seas coming ashore. Then, to prevent the seas from rolling in at the side, an offshore work in the nature of a jetty is projected out, something like that [illustrating], so that you have a little promontory sticking out into the Pacific, and then you have a line of breakwaters coming so, leaving between the end of it here and the jetty an opening through which vessels shall go.

Mr. PATTERSON. Now, there is a large body of red marked on the map?

Colonel LUDLOW. That red thing is intended in a vague, rough, and general way to indicate an interior harbor which would then be excavated out of the line of the canal. That harbor will be dug or dredged out.

Mr. PATTERSON. What kind of a country is that? Is that a low, flat country?

Colonel LUDLOW. No; there is that promontory which projects, and other ridges come down. It has an altitude of 150 or 200 feet.

Mr. PATTERSON. And the harbor lies between the ridges?

Colonel LUDLOW. The harbor lies between this little promontory and another promontory which comes off here [illustrating]. There is one here and one here. Both come down to the shore and one projects a little, and there is a bit of straight, sandy beach between those two. This river, the Rio Grande, comes in here [illustrating]. Here the waves come tumbling in, making this great surf which strikes on the beach. The entrance is to be made here and the real harbor then is to be excavated out of the land. The water deepens there very rapidly. You are in 10 fathoms very soon. In a mile and a half you have gone to 26 or 27 fathoms, and in another mile you have gained another 10 fathoms. On the Atlantic coast our depths run about a fathom to the mile, and in this case within 2½ miles we have 36 fathoms, or some such matter, on the Pacific. That is the reason these fearful swells come in, as there is no shallow water to diminish the roll.

Mr. DOOLITTLE. I would like to ask about what investigation, if any, you have made as to the draft of ships at present building and sailing on the Pacific and whether or not you have found the tendency to be to lessen the draft of vessels, modern-built ships, and increase the beam?

Colonel LUDLOW. Well, I can not say; we made very little investigation into that. It was a matter which rather affected the commercial statistics of the canal than an engineering point of view. As I remember, we took the general dimensions of large vessels, but we used them regarding the lock, length and width of the canal as quite sufficient, and we thought if the lock were wide enough to admit the United States war vessels it would answer all requirements. As a matter of fact, the tendency in the construction of shipbuilding is an increase in all respects.

Mr. DOOLITTLE. Not in depth?

Colonel LUDLOW. In length, width, and depth. It is found the larger vessels are more economical carriers than small ones.

Mr. DOOLITTLE. But I say, are not shipbuilders everywhere in the construction of the ships now using a flatter floor, a flat bottom?

Colonel LUDLOW. Less dead rise, that is true, but without diminishing the draft.

Mr. DOOLITTLE. Do you know what is the average draft now of a 4,000-ton cargo steamer, an English-built vessel?

Colonel LUDLOW. I do not remember, but I should think it would range from 19 to 25 feet.

Mr. DOOLITTLE. I think it ranges from 19 to 22 feet.

Colonel LUDLOW. Well, your information on that point is perhaps better than mine.

Mr. DOOLITTLE. I mean, of course, laden down to the marks.

Colonel LUDLOW. We were quite content in that respect to follow the project of the company and accept their depth of 28 and 30 feet.

Mr. DOOLITTLE. I could tell you of 2 or 3 lines of some 16 to 18 vessels to the line, like the Glenogle Line and similar lines, where the draft is not to exceed 23 feet.

Colonel LUDLOW. I saw a vessel drawing 19 feet 6 inches in the Suez make heavy weather of it, although there are 28 feet of water in the Suez.

Mr. CORLISS. I would like to ask one question before you conclude. In making the plans of the board, if I understand correctly, you proposed to maintain a level of 110 feet at the lake, and to maintain at all times a depth in the canal of 30 feet?

Colonel LUDLOW. We accepted the company's data in that respect.

Mr. CORLISS. You misunderstand me. In perfecting your plan, in making the extensions you deemed necessary, did not you figure upon a basis of a mean level of the lake of 110 feet and the depth in the canal of 30 feet?

Colonel LUDLOW. Yes——

Mr. CORLISS. That is what I understand.

Colonel LUDLOW. And we followed that, believing it was judicious because the company announced its intention of regarding that as a final project, and we had the authority of the chief engineer in his paper there in which, with some exceptions, 30 feet is carried through.

Mr. CORLISS. But in view of the developments of wider vessels and deeper-draft vessels you made these recommendations, deeming it necessary if the project was to be undertaken?

Colonel LUDLOW. We thought so. That was our judgment. And in view of the Suez Canal data we took the trouble to ascertain last summer when we found they had made that very considerable deepening; we did it, not because we believed it was extravagant, but because we believed it desirable.

Mr. JOY. I want to ask a question which I forgot to ask yesterday. You say the summit level of the lake was 101 and a fraction when you were there?

Colonel LUDLOW. There is no summit level.

Mr. JOY. Well, the level of the lake.

Colonel LUDLOW. One hundred and one and eight-tenths it was when we were there.

Mr. JOY. Where did you obtain your information as to the point below that at which the summit of the lake had been found—from what source did you get your information?

Colonel LUDLOW. I will read from the report what we put in in regard to that:

Mr. JOY. I noticed the statement, but I did not know whether it gave the source. Was your information derived from individuals or from a variety of things? Of course you could not see the water marks below the level of the lake.

Colonel LUDLOW. That comes under the general head of summit level. At the time of the gauging at Fort San Carlos, where the river leaves the lake and where we were detained two days, we tried to make good use of our time, and we made two gaugings there and investigated the lake bottom and also the Rio Frio, which comes in there and might interfere with the work. We say in our report:

In the report of 1890 the discharge from Lake Nicaragua at its lowest stage is said to be 11,390 cubic feet per second, and Colonel Childs is quoted as authority for an estimate of high-water discharge of 18,059 cubic feet per second. With these data a calculation is made, using the numerical mean of the two results to show that there will be a much larger water supply than required for canal purposes. Both the data and the method employed in this calculation are incorrect.

In Appendix C are given the results of all the gauging of the San Juan River of which the board has been able to find record. They consist of a series of gaugings made at different points along the river by Colonel Childs in 1851; of a similar series made by Commander Lull in 1873; of a single gauging made by the canal company in 1888, and of two gaugings made by the board in 1895.

All the measurements of the discharge of Lake Nicaragua have been made at low stage, but none at the lowest. The gaugings of Lull and Childs at this point agree as nearly as can be expected of gaugings made hurriedly and at such a long interval of time. The stage of the lake at the time of Lull's gauging, 102.28 feet above mean tide, has been erroneously accepted by the company as extreme low water. At the time the gauging at Fort San Carlos was made by the board, May 26, 1895, the stage was 101.8 feet, and the measured discharge 9,420 cubic feet per second, which accords very well with the results of Childs and Lull. A lower stage than this, however, has been of record more than twenty years. On the 2d of May, 1872, according to Lull's profile, the lake was 100.87 feet above mean tide. Still lower stages have been reported. The officers of the *Victoria*, a steamboat plying on Lake Nicaragua, showed to the engineers of the canal company a low-water mark whose elevation was 98.6 feet; this was confirmed by residents at the head of Kisma Lagoon, near the mouth of the Tipitapa River at the head of Lake Nicaragua, who pointed out a ledge of rock extending across the river which has been bare; its elevation is 98.5 feet. The very lowest stage known, observed at Granada, on the west side of the lake, is reported by Mr. William Klimie, an English civil engineer who has resided in Nicaragua for many years. Mr. Climie reports a stage of 96.6 feet above mean low tide.

Of course the information is extremely scanty, quite insufficient, but that is what we got.

Mr. NOONAN. I would like to refer to the sand foundation. You stated it could be utilized by boxing?

Colonel LUDLOW. I stated if you had sand packed and confined in some way it was as good to build upon as anything else.

Mr. NOONAN. What would you put upon that sand, concrete or rock?

Colonel LUDLOW. Well, I would work pretty hard to see if I could not find some bottom in there.

Mr. NOONAN. But assuming you had only a sand bottom?

Colonel LUDLOW. You could build a masonry dam there, but it would be a very expensive and dangerous thing; and the Board believes that if you use plenty of rock with due precaution, using plenty of it and using careful methods as you are building, and particularly if some means can be provided by which the excessive floods can be drawn off or reduced so the work would not be very seriously endangered during the construction period, we could get the dam built.

Mr. NOONAN. If you put the rock next to the sand there, would it jeopardize the safety of the whole construction?

Colonel LUDLOW. It works this way: You can check the flow of water through sand if you make it go through enough sand. In other words, if you make your dam long enough up and down stream—we estimate 900 feet will be necessary for that purpose—the friction of the water passing through the sand that long distance will check this flow. The dam will leak largely, there is no doubt. That is the fact in regard to all of those dams founded on sand. The water seeps through, but does not go through with any force, and if you can get enough rock in there you can get the dam built. We are satisfied of that.

Mr. NOONAN. If the sand has sufficient density as compared with the weight, it is safe?

Colonel LUDLOW. The sand per se is incompressible. It is made up of incompressible atoms, and when you get it in a compact——

Mr. NOONAN. Do you exclude the water?

Colonel LUDLOW. Of course that sand is going to be in water, but if you can keep the water from passing through that sand with such velocity as to carry the sand out, well and good; but, as a matter of fact, it is a little difficult; it is extremely difficult to determine what will be the effect upon the bottom of that head of water—60 or 70 feet—when you once get it there. We know very little about it. It might be the water would find some place in the banks where it would begin to pour through under that head, and of that we do not know. It would require the most careful investigation.

Mr. NOONAN. You present the thing as a problem entirely without question about the sand foundation?

Colonel LUDLOW. We get to the point of saying we could do it. We say we think it can be done, although it has never been done.

The CHAIRMAN. What would be the effect upon this dam constructed of loose rock, provided the water was permitted to pour over it or percolate through it in considerable quantity upon the lower level of the dam upon this foundation of sand; what would be the tendency toward undermining it and destroying the cohesion?

Colonel LUDLOW. It is unquestioned that the action of the water at that point would have to be watched with great care, and stone and materials to supply waste or injury must be on hand ready for immediate application. One precaution is in making the slope itself so flat the water shall come off sensibly parallel with the bottom so as not to have a plunging action. That must be avoided.

The CHAIRMAN. Is it practical to have that slope so that that will not happen?

Colonel LUDLOW. We think it can be done.

The CHAIRMAN. Do you think it can be done upon the hypothesis of the water pouring over the dam?

Colonel LUDLOW. No, sir; I beg your pardon there. The percolation of the water through it I was considering. The board is absolutely clear that no water whatever should be permitted to pass over that dam, because wherever that happens the destruction of the dam has almost instantly followed. I do not think any engineer in the country, I am sure, believes you could build a rock-fill dam and permit the water to run over it, and gentlemen of very extended experience with those works are all agreed on that point.

The board has no doubt whatever it would be extremely injudicious to undertake anything of the kind. The water must not go over that dam. It is all loose material to handle, and the passage of water over that dam will attack not the body of the dam, but will attack the nearest piece of rock with which it is in contact. It is not the mass of the

dam it deals with at that point at all. It is nothing but an individual piece of rock, with no other resistance to the action of the water than its own weight, and to such an extent as it may be jammed against the adjoining pieces. Furthermore, the weight of these blocks is reduced by virtue of the fact that they are below the surface of the water, or partially submerged, and to that extent their actual weight is reduced. A block of stone which weighs 5 tons in the air does not weigh that under water. You have to reduce the weight by the amount of cubic feet of water it displaces.

I may say with regard to that, another grave doubt introduces itself. It is proposed, of course, to build this dam out of the material to be taken from the east divide, a perfectly rational proposition. It remains yet to be actually certified as to whether the rock out of the east divide can be gotten out and handled in sufficient mass so you can get big enough stones to tumble in there. At the entrance to the Suez Canal at Port Said they use great blocks of 22 tons of solid concrete, yet the action of the sea on those blocks—it is only a moderate sea in the Mediterranean—carries them off at the rate of about thirty or forty a year. So they have to keep a constant supply for the jetty which extends into the Mediterranean.

Now, you want to get blocks of that kind out for that purpose in the east divide, both for Greytown Harbor and the Ochoa Dam. They can not be too large, and whether this curious volcanic rock, which has all sorts of characteristics, most unexpected, if you like, and much of which is soft, is possible to be obtained in such masses, we do not know. Suppose you get that rock out of the east divide and put it in the Ochoa Dam, and under the action of the air and water this volcanic rock begins to decompose and run to mud? Then "where are you at?" so to speak. These contingencies we could not answer. We had not the information to deal with them at all.

Mr. CORLISS. There is one question I would like to ask the Colonel, just for personal information. Taking into consideration your investigation of this enterprise and the great benefit it would be to the American nation, or the American nations and commerce, do you not deem the investigation to have progressed far enough to warrant the acquisition by the Government of the right of way and concession and to enter into negotiations for the ultimate construction of it and control of it by the United States Government?

Colonel LUDLOW. Do I believe it would be wise to enter into negotiations with those two States to acquire this concession?

Mr. CORLISS. To obtain the right to construct the canal by the United States Government.

Colonel LUDLOW. I should think that it might be a very wise precaution to let it take that form. That is not an engineering question——

Mr. PATTERSON. It is not an engineering question.

Colonel LUDLOW. It is more a political question——

Mr. JOY. A diplomatic question.

Colonel LUDLOW. I do not know how the present concession is, but I heard the chief engineer say it expires in 1899.

Mr. CORLISS. The question is simply whether the United States Government, in your judgment, should have this right to construct and maintain a canal there?

Mr. JOY. I submit that is a diplomatic question.

Mr. CORLISS. I realize it is, but I did not know whether the Colonel cared to——

Colonel LUDLOW. It is a political question, and we have not entered

upon that at all. When we examined the construction of Greytown Harbor we ignored the fact the line we proposed was over what was claimed to be the boundary, because we did not believe this work should be considered in that connection at all. The crossing of the boundary does not amount to a row of pins in comparison with the serious effect on the very formidable construction of that harbor.

The CHAIRMAN. There is a question which I would like to ask which I think would be entirely legitimate for you to answer. While you were in Nicaragua engaged in your duties, what did you discover, if anything, with reference to the feeling of the people whom you came in contact with respecting the Government of the Unitd States participating actively, and perhaps in the sense of control, in the construction of this work?

Colonel LUDLOW. I do not think, really, sir, we had any touch with that question. I do not remember that we had. I will say the Nicaraguan authorities treated us with extreme courtesy.

The CHAIRMAN. You found nothing but friendly feeling?

Colonel LUDLOW. Nothing at all but friendly assurances and courtesies and welcome.

The CHAIRMAN. And they manifested an interest in the enterprise, did they?

Colonel LUDLOW. They did manifest an interest to this extent—they sent down two commissioners to meet us, who were specially accredited to meet us at the wharf and extend all facilities that they could, and they gave us the use of the State telegraph.

The CHAIRMAN. And they knew you were there, of course, representing the United States Government?

Colonel LUDLOW. They knew our errand, and we were received, although not formally accredited to the Government in any sense; they met us with a salute of 11 guns, and we exchanged courtesies and calls, and that was done all the way up the river by both garrisons, and also at Managua.

Mr. WANGER. And they knew your business there was in connection with the projected canal?

Colonel LUDLOW. Yes, sir; the commissioners were sent down to meet us for that purpose. It was quite well known in Nicaragua in regard to our coming, because the company were making preparations to receive us.

The CHAIRMAN. And you are satisfied you were favorably received?

Colonel LUDLOW. Absolutely; there was no shade of a discourtesy at any point. On the contrary. There were a few drunken men cursing the Yankees at a few places, and we had to look out for fear of some of them knifing some of our party, but——

Mr. NOONAN. Probably it was the influence of whisky?

Colonel LUDLOW. These commissioners did notify us at Greytown, before we started out on our quest, that we could not go and look at the Colorado with the idea of carrying the canal down that stream, but of course we did not pay attention to that. We considered the matter solely as engineers.

STATEMENT OF MR. A. G. MENOCAL—Resumed.

The CHAIRMAN (to Mr. Menocal). Have you anything you desire to say?

Mr. MENOCAL. I do not think I need to say anything. What has been said here to-day had been stated in previous testimony, and I have

gone over it in my original written statement and previous testimony before the committee. I do not know that I have anything to add; but I will be glad to answer any questions from you or any member of the committee. As to the question put by Colonel Ludlow, whether I have been over these hills personally, I should answer——

Colonel LUDLOW. That was not my question.

Mr. MENOCAL. I explored that region, I pointed out on every one of those hills where embankments should be built, and put the engineers there to work developing the topography. Its development was finally concluded about 1891. I was rearranging the line of the embankments just before I left, in order to conform it to the topography as developed by the engineers, and some slight changes were made from one hill to another in order to get a better location, and I will add that since that final development of the topography by the engineers I have not been over the line finally located over those hills, but I have been over every individual hill, and I selected the line of embankments.

Colonel LUDLOW. Now as to the other, if you please.

Mr. DOOLITTLE. You need answer only questions put to you by the committee.

Mr. WANGER. I adopt the question.

Mr. MENOCAL. If he refers to the San Carlos region, I have explored the San Carlos and all those hills, commencing in 1873 and again in 1885. I have examined that region and those hills in the valley of the San Carlos, and placed engineers there to develop the topography, and from the development of the engineers the embankment line was laid down. Since that embankment line was laid down I have not been over the line myself. There was no necessity for my doing so. That is a statement of the facts. I selected the line for the embankments over those hills, and while there may have been slight changes in the final location of these embankments from one hill to another—but that strikes me as rather immaterial, as I have been over the ground, every foot of it.

Now, this board seems to admit the practicability of the canal as laid down by the company's plans with some modifications on which we do not agree entirely, but I have treated those questions in my written statement. The question as to how much you can do a piece of work for can be settled only by bids from different contractors who may be found ready to do the work.

Mr. WANGER. What is the basis for the belief that rock can be taken out in blocks of sufficient size from the cut in the east divide to build the piers at Greytown and Ochoa Dam?

Mr. MENOCAL. From the fact that similar work has been done in a great many parts of the world and is now being done in the United States. There is no doubt you can get large blocks of rock if you use the proper appliances to do it with.

Mr. WANGER. Is it from borings, or what form of investigation of this particular rock bed?

Mr. MENOCAL. Borings have been made there. Colonel Ludlow has read the report of the geologist in regard to the quality of rock. We believe there is plenty of rock hard enough for the construction of the breakwater, and also for the construction of the dam. Is that the question?

Mr. WANGER. Yes, sir.

Mr. MENOCAL. From the borings which have been carried to the level of the bottom of the canal at about 1,000 feet from one to another, the character of the rock in sight at the numerous rapids, and the opinion

of the geologist, we have come to the conclusion that we have a sufficient amount of rock there for the construction of the dam and the breakwater, and that it can be obtained in blocks of the size required for the work.

The CHAIRMAN. Did you find any imperfect rock by those borings?

Mr. MENOCAL. Yes, sir; some of the rock is harder than others. It is not quite uniform, but we believe there is sufficient hard rock for the works proposed.

The CHAIRMAN. Might not that rock turn out to be not adapted to exposure?

Mr. MENOCAL. It is possible for a portion of it. What has been classified as soft may turn out to be of inferior quality for the construction of this work, but we believe there is sufficient and a great deal more than is needed to construct the works we propose.

Mr. BENNETT. Mr. Chairman, I move we adjourn.

Mr. JOY. I ask the privilege of five or ten minutes' hearing for Mr. Hubbard at our next meeting.

Thereupon the committee adjourned.

WEDNESDAY, *May 9, 1896.*

The Committee on Interstate and Foreign Commerce this day met, Hon. William P. Hepburn in the chair.

Mr. DOOLITTLE. Mr. Chairman and gentlemen of the committee, Governor MacCorkle, of West Virginia, has kindly consented to appear here and discuss certain phases of the Nicaraguaan Canal matter.

The CHAIRMAN. The committee will be pleased to hear him.

STATEMENT OF GOVERNOR WILLIAM A. M'CORKLE, OF WEST VIRGINIA.

Governor MacCorkle said:

Mr. CHAIRMAN AND GENTLEMEN OF THE COMMITTEE: I appreciate very much the courtesy of the committee and will make my statement as concise as its subject-matter will allow me to. I am very well aware that the committee, in not confining me in reference to time, is doing me and the section I represent a very great favor. I will confine the discussion to-day to the relation which the Ohio River Valley bears to the Nicaraguan Canal in reference to the production of coal. Unless particular attention has been directed to this especial subject it will be very hard to appreciate its vast importance to the people of the United States. A very peculiar thing is taking place upon the Pacific Coast. The Pacific Coast of the United States, as well as the West Indies and Southern and Central America, is almost dominated by foreign coal. As a matter of fact, either Great Britain or its dependencies furnish this coal, when every bushel of coal, either on the Pacific Coast, in Southern and Central America, or the West Indies can be furnished more cheaply by the Appalachian coal chain, lying largely in the Ohio Valley, than by any other section of the world.

The CHAIRMAN. By the canal?

Governor MACCORKLE. Yes, sir. This, of course, can be done only through the construction of the Nicaraguan Canal. I will proceed to give my reasons for this proposition.

There is no portion of the United States which will be benefited by the Nicaraguan Canal as the Ohio and Mississippi valleys, particularly

the Ohio Valley. In the mere matter of coal the benefit to the Ohio Valley will be incalculable. My limited time will not allow more than a cursory discussion, even of coal. The advantages to the Ohio Valley in its relation to its very multitudinous products will not be discussed. The highest development of the Appalachian coal chain takes place in West Virginia, Pennsylvania, and Kentucky, and from this great body of coal will come in the future the great bulk of supply of the world. Within the Appalachian chain there are about 64,000 square miles of coal. The cuttings made by erosion and by the various agencies of nature have adapted this coal to easy mining and transportation to a greater extent than any other coal of commerce. The coal formation of the Appalachian coal field has a deposit, which, in the aggregate, will amount to 9,000 feet, and in this field there are more than 100 distinct workable coal measures.

The Appalachian field furnishes about two-thirds of the output of bituminous coal in this country and all but 4½ per cent of the total production of coke. The vastness of the coal trade of this field is hardly appreciated. Just in one comparatively small district alone, the Pittsburg district, we have $50,000,000 in coal investments. The value of the coal output last year in this country amounted to $200,000,000.

This great Appalachian field is about 900 miles in length and from 50 to 180 miles in width, and extends from northern Pennsylvania to middle Alabama. It embraces the Ohio Valley, western Pennsylvania, Ohio, West Virginia, eastern Kentucky, and the Elkhorn district of Virginia. This area embraces the largest and best parts of the Appalachian coal field.

I generally use West Virginia as an illustration because this State has within its borders a greater amount of the Appalachian coal field than any other State. It has more that 80 per cent of the total bituminous areas of Ohio and Pennsylvania combined. It has more than Pennsylvania alone and 2,000 square miles more than Kentucky and Tennessee combined.

In Kentucky the coal-bearing rocks within this field have a thickness averaging 2,000 feet, and there are from eight to ten merchantable coals within her boundaries, and all are splendid coals, Kentucky having both the Illinois and the true Appalachian coals.

Mr. BENNETT. You spoke a moment ago about the strata of the Appalachian coal chain; you said something about 2,000 feet. What do you mean?

Governor MACCORKLE. I mean the coal-bearing formations in Kentucky.

Mr. BENNETT. Is that in direct depth?

Governor MACCORKLE. That is not always the absolute depth.

Mr. BENNETT. What depth is the deepest vein you know of in the Appalachian mine region?

Governor MACCORKLE. The good merchantable coal in the Appalachian coal chain averages from 3½ to 11 feet. Of course, the latter is extreme, but obtains in a number of places in West Virginia, Kentucky, and Maryland, and several places in Pennsylvania.

Mr. BENNETT. To what depth below the earth's surface do you follow the coal in the Appalachian coal chain?

Governor MACCORKLE. Various depths. Throughout Kentucky and West Virginia there are very few shaft mines. In Pennsylvania there are more, but the majority of the mines in the Appalachian coal chain are above ground and in the mountain side. The mines in a vast number of instances drain themselves. The veins in the great majority

of instances lie uniform and level. This causes our mining to be so marvelously cheap in this great coal field. For instance, in Australia, Nova Scotia, British America, and in a number of the Western States and in England they are compelled to burrow great distances in the ground in order to get the coal. In many instances in England they are 2,000 feet in the ground. This is not the case in the Appalachian coal chain.

On the basis that the Ohio Valley has the best and cheapest coals in the world, it should supply the greatest part of the increase needed by the world's demands. The coals of this coal field are the greatest and best formations. It is true the Western coals are fair coals for some purposes, but in matters relating to steam raising and iron making none of the Western veins of coal are at all comparable to the coals of the Appalachian field. In many of the States of the West they have big veins of coal, but the highest development as to quality is never seen in the West. All of the Western coal fields are more difficult to mine than our Eastern or Appalachian coals, and none of them have the purity of the last-named coals. The Vancouver Island coals are the best American coals supplying the Pacific market, and, except the Japanese coals, about all of the coals imported and in full use on the Pacific Coast are from the British possessions. The Western United States coals, possibly excepting Washington coals, can not compete with the coals of the British possessions. This results from two circumstances: First, the quality of the coal is not so good; second, the high rate of railroad transportation in the West, and long distance from point of production to point of consumption.

The Vancouver Island coals are fair coals, and while they are generally better than the Western coals, they belong to the recent coal formations. This is the case with nearly all of the Western coals. They are not generally good steam-raising coals, because of the great abundance of sulphur and ash, and because of their absolute destruction of boilers and fire boxes and of all appliances in which they are used.

The coal of Vancouver Island, as I said before, is good coal, but not comparable to our product. For instance, take the Wellington coal, which is considered the best on the Pacific Coast, and compare with the West Virginia coal. In the Wellington coal the fixed carbon is 56.54; volatile matter, 34; water, 2.05; ash, 7.41. Now, compare with the Elk Garden coals of West Virginia. The fixed carbon of the latter is 76.28; volatile matter, 19.25; ash, 3.02; water, 0.98.

Thus you will see, by a simple comparison of analyses, the immense superiority of the Appalachian coals over the best coals of Vancouver Island. These latter coals are confidently relied upon, when their development is completed, to control all the Western coast trade, including Central and South America.

The Western coals are generally brown coals or lignites, not yet developed into good coal, and in no sense of the word compare either for domestic uses or for cooking purposes or steam-raising purposes with our splendid coals. They are not the true carboniferous era coals. They have too much water and are of a woody texture. They slack too easily, and the draft forces burning particles through the screens. Vast sums of money have been spent in preparing appliances for the use of these coals, so as to make then valuable for the various uses of commerce, but as yet none have been discovered which make these coals in any way the equal of our splendid Appalachian coals.

In the Western States transportation is the great question, and nowhere in the world can overland railroad transportation compare with water

transportation. In every instance the coals which have water transportation can be marketed at very much cheaper rates. The water transportation would average about one-fifth per ton per mile the cost of the railroad transportation. The river transportation and water transportation, for instance the transportation on the Ohio from Pittsburg to New Orleans is about one-twentieth of a cent per ton per mile. Hence, the coals of Colorado, which are perhaps the best coals in the West, are not readily available for use on the Pacific Coast because of the great cost of transportation. So it is with the coals of Washington, which are very good coals, but unless they are immediately near the seacoast the cost of transportation is too high to make them available for all of these purposes. The State of Washington, outside of the Appalachian coal chain, is the only hope of successful competition with British coals. In Texas there is a vast amount of coal, and such is the case in New Mexico, but these coals are not likely to compete with the Appalachian coals. Generally speaking the coals of these States, and, as I have said before, of principally the whole West, are the brown coals more nearly approaching lignites.

Then, as a matter of fact, the only coals which can compete on the Pacific Coast with the British Isles, Australian, and British American coals, and the Japanese coals are the coals of the Appalachian field, and the question is how to supply the Pacific Coast with these magnificent coals.

The initial price of coal in this country is less than in any other country. It is from 60 to 85 cents per ton at the mines in the Appalachian coal field, the average price per ton at the mines in West Virginia in 1894 being 75 cents, the cheapest in the world. This as against $1.24 in Colorado, $2.33 in Washington, 93 cents in Alabama, and as against about $1.87 per ton in Belgium, $2.25 in Japan, from $1.75 to $2.25 in New South Wales, and from $1.65 to $2.25 in Great Britain. It will be understood from this statement that only cheap transportation is needed for the coals of the Appalachian coal field to control the coal consumption of the Pacific Coast.

England is a great producer of coal and puts out about 185,000,000 tons per year as against about 170,000,000 in the United States. The United States produces about 30 per cent of all the coal of the world, and it is absolutely necessary for our development in the production of coals that we take charge of the markets of the Pacific Coast and of South and Central America, Mexico, and the West Indies. Great Britain exported 33,000,000 tons of coal as against only about 2,000,000 tons of bituminous coal exported from the United States in 1894. England sends about 200,000 tons to the Pacific Coast, and about 880,000 to Brazil, 750,000 to the Argentine Republic, 340,000 to Chile, and 44,000 to Peru.

England ships every year to these latter markets 2,500,000 tons of coal.

Mr. BENNETT. When you spoke of British, what territory does that expression include?

Governor MACCORKLE. As I have used it above, I mean England proper, Wales, and Scotland.

Mr. BENNETT. You did not take in by that the Australian and British-American mines?

Governor MACCORKLE. No, sir.

Mr. BENNETT. Then they are not included in the total of about 185,000,000 tons?

Governor MACCORKLE. No, sir; I meant the British Islands alone, which mine from 185,000,000 to 188,000,000 tons of coal.

This country should control these markets for the simple and natural reason that we are nearer to them, and our relations are in every sense of the word closer than in Great Britain. The coals of South America, so far as they have been developed, do not show their ability to successfully compete with the Appalachian coals. The coals of the Republic of Colombia are fairly good, some of them very good, but as a matter of fact they will not be able to compete with ours. In Chile, which at one time was heralded as a great coal-producing State, latest investigations have not carried out the ideas which were once conceived concerning the coal. The veins are thin and the coal not of the best quality, and can not compete, or only to a very small extent, with our coals. Such is the case with Mexico. There seem to be some good coals in Alaska, but as yet little is known about them.

Mr. DOOLITTLE. Would not the cheap coals coming through the canal stimulate manufacture on the Pacific Coast, and would it not stimulate immensely the mining interests of the country?

Governor MACCORKLE. Immensely. The trouble is, the Pacific Coast is killed as a manufacturing section by reason of the high price of fuel. Six dollars to $8 is too high for fuel.

The Pacific Coast should be one of the great manufacturing sections of the world. It has splendid minerals, magnificent forests, and the finest timber in the world. It has very fertile soil, a delightful and equable climate, energetic people, and is splendidly situated in reference to the Orient. It has a vast number of products needed in manufacture, and at the same time what is manufactured on the Pacific Coast can be taken cheaply to the market of the East and sold to a very great advantage. So, as a matter of fact, one of the great demands of the western coast will be for coal. Every consideration of economy, as well as every consideration of national pride, is opposed to our absolute dependence upon British possessions for the coal which is the foundation of the prosperity of this great manufacturing section. The only hope of our successful competion with British coal is through the Nicaraguan Canal. Railroad transportation across the continent is out of the question.

In West Virginia, which is a fair center of the Appalachian coal field, we are mining and loading coal at 60 to 85 cents per ton on cars and $1.80 f. o. b. at the coast. We are mining cheaper coals than the Japan coals. Her coals cost her $1.50 f. o. b. at the mines, although she pays her miners only 6 cents per day.

Mr. DOOLITTLE. They are selling bunker lots at $4.25 under contract and $4.50 for shipment.

Governor MACCORKLE. That is true. Yet, notwithstanding this, Japan is driving Australia and Great Britain out of the eastern market. In the port of Hongkong, which is getting to be one of the greatest coal markets in the East, the Japanese coals are really dominant, and as they develop the large territory which is in the Island of Formosa, as well as Miike in southern Japan, her influence will be more greatly felt day by day. She will become a great competitor, but our coals, for the reason I have given, will undersell her. The New South Wales coals and the English coals are worth about $1.75 to $2.25 per ton at the pit mouth. The English coals cost from $4 to $6 per ton delivered in London, while our good coals are carried about 600 miles and laid down f. o. b. in New York Harbor at from $2.40 to $3 per ton. Therefore any enterprise which will allow the coals of this great Appalachian field, and particularly of the Ohio Valley, to be sent to the Western market will benefit both this market and this great valley to an

immeasurable extent. At the same time it will be of incalculable benefit to the Pacific Coast.

By the construction of the Nicaraguan Canal, the price of coal up and down the coast of the Pacific will be lessened to a very great extent. The obvious advantage of this canal will be seen both in time and rates.

The CHAIRMAN. Let me ask you what would be the freight charges from New Orleans to San Francisco through this canal on the basis of $2 a ton toll.

Governor MACCORKLE. The distance from New Orleans to San Francisco by the present route is 4,080 miles. I give the toll at $1, but even at $2 toll, leaving 4,000 miles for ocean traffic, you will still see that we undersell the British-American and the Pacific Coast coal. It will not take, of course, $4 per ton freight. At the present rate you can calculate the general rate at $8 per ton on coal. This is safe and conservative. The present run is 15,000 miles. The run through the canal is only 4,000 miles—a little more than one-fourth of the original distance. The reduction in freight would be obviously one-half and more, to say the least, because there is only one-third of the distance by the canal.

By railroad across the continent freights are from $20 to $30 and the time is from twenty to twenty-five days. By sailing vessel around the Horn it takes one hundred and twenty days, and the freight rates are from $8 to $10 per ton. By the canal this time would be reduced to thirty to forty days, with a reduction of at least one-half in freight charges. Steam vessels through the Straits of Magellan now take from forty to fifty days, with freights from $10 to $12 per ton. This time will be reduced from seventeen to twenty days in length of voyage, with the freight rates correspondingly reduced.

The quotations at San Francisco are as follows: Puget Sound coal, $6 to $7; Southfield, British Columbia, $7.50; Wellington, British Columbia, $8; Australian and European coal, spot lots, $5.25 to $6.59, with an average of British island coal at $6.50 to $7.

The coal of the Ohio Valley can be placed in the harbor of San Francisco at from $4.50 to $6.50 per ton, with steadily decreasing price, leaving out the consideration of the vast difference in quality in favor of the coal of the Ohio Valley. By the building of this canal we have the advantage of distance over any other coal excepting the Pacific Coast coal, which, as I have shown before, can not enter into competition with the Ohio Valley coal, the advantage of quality always being in favor of the Appalachian coal at from $1.25 to $2.25 per ton. All the advantage of a vast unrestricted market will accrue to this valley from the construction of the Nicaraguan Canal.

The CHAIRMAN. What is the estimated consumption of the Pacific Coast of coal?

Governor MACCORKLE. As I understand, you mean the Pacific Coast of the United States. According to Mr. Saward, probably the most eminent authority we have on the coal trade, the tonnage last year for San Francisco was 1,600,000. Out of this tonnage only about 500,000 tons came from the United States; this included about 150,000 tons from Seattle and about 260,000 tons from Diablo and Coos Bay. The rest came from British territory, including 650,000 from British Columbia.

I would think that the consumption along the coast, outside of this city, would amount to between 600,000 and 900,000 tons, making the consumption of that coast nearly 2,500,000 tons. Continuing down the coast you will find Great Britain exported into Mexico 140,000 tons, of

which one-half came in by the west coast, Acapulco being a good market. From the United States there were shipped to Mexico, according to Mr. Saward, about 100,000 tons of bituminous coal. The coal trade of Mexico, upon a fair calculation, would develop through the canal to the extent of about 250,000 tons within two years. I think this would be a very conservative estimate. At Central America the coal trade, of course, would be confined to the canal. The best experts have calculated that the canal and its shipping would annually require about 2,000,000 tons of coal. It will naturally become one of the great coaling stations of the world, because there is more money in carrying freight than coal. Upon a calculation which I will give you a little further on, you will see that of this 2,000,000 tons of coal, at least four-fifths will be furnished by the United States, for the reason that we can place the coal at Panama or at the Pacific end of the Nicaraguan Canal for less than $4. It is costing to-day by normal rates from Europe $10 to $11.

Now as to South America, Great Britain shipped to Peru last year 44,000 tons. There was from her own mines, from Australia, and from Germany between three and four times as much more, which would be 150,000 to 200,000 tons, of which amount at least one-half would come from the United States. Chile received 340,000 tons last year from Great Britain. There were shipped into her by other nations at least 100,000 tons, making 440,000 tons last year. The United States should have at least half of this tonnage of coal. Therefore, including the 2,000,000 tons used on the canal, of which one-half will be stationed for consumption on the Pacific Coast, to the whole Pacific Coast, from California to Chile, there were imported 4,000,000 tons of coal. With the calculation as to price, as I have shown, it seems to me, and I believe to everyone who understands the question, that there should pass through this canal about the first year or two from the Appalachian coal field the vast amount of 2,000,000 tons of coal.

I have discussed the mere region of the Pacific Coast, but it is only a very small part of the world which will be controlled by our coals. As soon as we turn our attention to the markets of the world, particularly those of South America and the Pacific Coast, a vast trade region will be opened up, which is to-day controlled by our British competitors. At Maranham, Brazil, the distance is 3,800 miles from Newport News, a middle Atlantic seaport. There Cardiff coal costs them $12. We can give them coal at about $5. At Pernambuco, British and German coal is used at $11 to $15 per ton. Including 4,080 miles of transportation from New Orleans, we can sell them coal at $5.50 per ton. At Montevideo the British coal costs $13 per ton. We can put the Appalachian coal in that market at $8 per ton. At Acapulco, Mexico, Cardiff coal costs them $20 per ton. This market is only 2,200 miles from New Orleans, and we can place our coals there at $5 per ton. At Callao, Peru, Cardiff coal costs $15 per ton. This market is 2,984 miles from New Orleans and 3,455 miles from Newport News, and we can place coal there at $6 per ton. Valparaiso, Chile, uses Australian coal, which costs $8 per ton. This is 4,200 miles from Newport News, and we can place our coals there at from $5.60 to $6 per ton.

From the mouth of the Kanawha River, in West Virginia, to New Orleans, the operator has the cheapest transportation in the world. The transportation on the Ohio and Mississippi rivers is the cheapest inland transportation in the world. The plan in operation is by steamboat and barges, such barges carrying from 10,000 to 15,000 bushels, and averaging about 500 tons. On the Ohio River a towboat will

carry a fleet of about 30 barges of about 500 tons, or about 375,000 bushels. This vast fleet is handled by one comparatively small steamboat, and, as is well observed by an authority on such matters, each one of these fleets would make 30 trains of 25 cars each, or a continuous line of cars about 5½ miles long. When at New Orleans or the mouth of the Mississippi, the coal is elevated into seagoing vessels and shipped to its point of destination.

By the construction of the canal, instead of the long tempestuous route around Cape Horn, with all of its uncertainties arising from the perils of navigation, there will be a comparatively short run from the mouth of the Mississippi, across the Gulf of Mexico, through the canal, and up the Pacific Coast, amounting to only 4,000 miles as against the 15,000 miles journey which eastern products are to-day compelled to take. A very small calculation will show our ability to undersell the other coals spoken of elsewhere. Our coals cost, as I have said before, from 65 to 85 cents per ton at the pit mouth. It costs about 80 cents per ton transportation to the mouth of the Mississippi. The tollage through the canal will amount to about $1, leaving 4,000 miles for ocean transportation, we will allow from $2 to $4 per ton. This, at $2 per ton, is one-twentieth of a cent per ton per mile, or double that at $4 per ton. The rates from San Francisco to Liverpool are from $7.50 to $10 for 15,000 miles. This is from five-hundredths, or one-twentieth, to six and one-half hundredths of a cent per ton per mile; the reduction in rates will be proportionate on reduced distances. This, with insurance and incidentals, will bring the cost of a ton of the best Appalachian coal to from $4.50 to $6.60 at San Francisco.

That this is a fair statement is evidenced by the fact that the sailing vessels carry coal at from $7.50 to $9 per ton around the Horn, a distance of about 15,000 miles. The canal saves about two-thirds of the distance. This statement is borne out by the price of Eastern coal at San Francisco; the last quotation was from $9 to $10 per ton. By this route we will have largely the advantage in mileage of the Welsh and English coals.

Mr. BENNETT. Have you estimated any canal rate in passing through the canal?

Governor MACCORKLE. I have always estimated that we ought to put this at from $1 to $1.50. I think that on a cheap merchandise, like coal and nitrates, the rate could be placed from $1 to $1.50. In the Suez it was reduced to between $1.80 and $1.90, and I think they will steadily reduce this rate. They could reduce it on the Suez Canal, and still have a large per cent in excess of a reasonable rate. I will discuss the question a little later on.

Mr. BENNETT. As I understand, you could afford to use the canal at a toll of $1.50?

Governor MACCORKLE. Yes, sir; we could use it at $1.50, and, upon a calculation which I made a few moments since, we could go as high as $2 in the carrying of coal and undersell the coals marketed upon the Pacific Coast.

Mr. DOOLITTLE. That leaves you a margin of over $3?

Governor MACCORKLE. Yes, sir; you could put it at $2 toll through the canal. We will have by far the advantage of any other coals by shipping, even if we do not utilize the Ohio and Mississippi rivers, for we can place coal at Newport News, Baltimore, or Norfolk, which are the three great ports of the Ohio Valley, at $1.80 per ton, and ship it by vessels through the canal, and undersell any other coal. To-day we are shipping coal by rail 300 or 400 miles to Baltimore, Norfolk, and

Newport News, sending it around Cape Horn and delivering it at San Francisco (a water run of nearly 15,000 miles) at $9 to $10 per ton. How incalculable will be our advantage when this tempestuous and extended ocean voyage is reduced from 15,000 to 5,000 miles.

Mr. DOOLITTLE. What is the distance from the coal fields to Newport News?

Governor MACCORKLE. About 400 miles.

Mr. DOOLITTLE. What is the cost per ton per mile, generally speaking?

Governor MACCORKLE. About one-fifth of a cent. As I said above, we put the coal on shipboard at Newport News at $1.80 per ton.

Mr. DOOLITTLE. What is the traffic on the Ohio River?

Governor MACCORKLE. It is about one-twentieth of 1 per cent, as I have said above.

Mr. JOY. And that is all the way down the Ohio and Mississippi, too?

Governor MACCORKLE. Yes, sir; this applies from the Pittsburg district to New Orleans—that is, when the coal operator owns both barges and steamboat.

A fair illustration of what we can do was best seen in March, 1895, when the Davis and Elkins mines of West Virginia coaled our war ships at Trinidad. Coal there costs about $7 to $8 per ton. We placed it on the ships at $5.85, and on the other side of the Isthmus our war ships paid about $11 per ton. We can place it there very easily for less than $5. The Navy Department saved from the above-mentioned transaction alone $50,000.

These are a few illustrations of what can be done in the way of taking control of the great West Indian market and of the markets of the Pacific Coast and of South America. After all of their investigations and after all the vast expenditure of money by capitalists interested in the South American Continent and the Pacific Coast, no coals have been discovered which are in any way comparable with ours.

Let us discuss the question of distance between the Appalachian coal field and its competitors. The Japan coals are compelled to undergo a voyage of 4,791 miles from Yokohama to San Francisco. Australian coals travel from Sidney to San Francisco, 6,514 miles. From Newport News to San Francisco it is about 4,500 miles; from New Orleans to San Francisco it is 4,047 miles; from Liverpool it is 7,500 miles; from New York it is 5,000 miles; from Port Townsend to Valparaiso it is 5,840 miles; from Newport News to Valparaiso it is 4,400 miles. These distances are through the Nicaraguan Canal. Thus you will see that we have the advantage over the Japanese coals; about 2,000 miles advantage over the Australian coal; about 3,000 miles advantage over the British Island coal.

Our advantage is further emphasized by the comparison of distance between Port Townsend and Newport News with Valparaiso. It is confidently expected by the great coal companies of the Cammox and Wellington fields in Vancouver that they will supply the whole western market of South America.

By the canal taking Valparaiso as a point on the western coast of South America we will have 1,200 miles at least advantage in distance over the Vancouver Island coals. In other words, with the canal constructed, neither England, Vancouver Island, Australia, nor Japan should be able to sell a pound of coal within the borders of the United States.

The high price of the Vancouver Island coal in San Francisco is caused by the high price of mining, as it is only a distance of 700 miles navigation.

Ultimately, Mexico and the South American States will be great producers of iron and form there a ready and needed market. In almost every case we can ship our coals and coke to the regions needing them more cheaply than they can be mined in those countries. In Mexico there are some splendid deposits of iron ore. In many instances these ores will yield more than 66 per cent of the metallic iron. Such is the case in Peru, Chile, Venezuela, and Brazil. In all of these States there are great deposits of iron ore and our cheap fuels will be absolutely necessary for their development.

Many of the South American States have within their limits splendid gold, silver, lead, and quicksilver deposits, which will be opened soon to the world's commerce. In this rich region our coals will most certainly play the important part. Should we not be ready to take advantage of the certain opening of these great markets? It is the duty of everyone interested in the development of the Ohio Valley to see that this canal is constructed, and in the mere question of coal alone there would be a trade evolution throughout the length and breadth of the valley watered by the Ohio River.

I have alone discussed the question of the production of coal in the Ohio Valley and the possibility of new markets for the reason that a general discussion of the advantages which would accrue to the Ohio Valley would take too much time and space; but the application of the discussion of coal can be made to the vast number of products in this great valley.

Now, as a matter of fact, for the proper development of our great coal regions, new markets must be opened. Our production and consumption must be extended. Such is the condition of affairs to-day from our restricted market that last year the Pennsylvania miners only worked about two hundred days in the year, and the Ohio miners worked one hundred and seventy-four days. This statement is further emphasized by the figures of the total production in the United States. In 1894 the total number of men employed in coal mining was 376,206, who worked only an average of one hundred and seventy-eight days, slightly more than half time. This one-half time labor and the present development of this great resource of national wealth is sufficient for our present markets. For the protection of this vast body of intelligent laborers, and as an incentive to the development of our great coal regions, it is absolutely important for us to command the markets of the world. It is not just that with our vast creative energy, with our ability to compete, that this great production should be confined strictly to home market. By what means can we obtain this market so easily as through this canal, which will allow us to go into the South American market, and which will allow us to compete in our own country with the Japanese, the British Columbian, the Australian, and the Englishman? With our cheap initial cost of production, the foreigner should not be able to compete with us in the production of coal.

Mr. DOOLITTLE. Do you not believe that mining would be stimulated by the construction of the canal?

Governor MACCORKLE. Immensely. The trouble of the Pacific Coast is that you are being killed by the want of fuel. You can not manufacture cheaply with coal at $8 to $10 a ton.

Mr. JOY. Digressing from the question of coal, have you considered what amount of commerce from Eastern seaport States will pass through the canal for the Western coast of the United States and South America or for Japan and the eastern countries? Have you considered what that will amount to per year, what it will consist of, and what countries

it will embrace? I will be glad to have your views on this general question.

Governor MACCORKLE. Yes, sir; I have considered that question. I come prepared to-day to bring an argument before the committee to show exclusively that this coal question is one of the most important, and to show the committee that the United States should absolutely control its own coal traffic, and that to mean to do so is by constructing this canal; but I will take pleasure in giving you my views of this question. It is very hard to make calculations as to increase of traffic, especially increase of traffic in this free country of ours. All the questions of increase of traffic in the Suez Canal have been entirely done away with by the reality. This is the case in the comparatively well-settled mercantile countries of Europe. How can we make any comparative basis when we consider the phenomenal development of this country? The tonnage of the world to-day amounts to nearly 70,000,000,000 tons. In about twenty years it has been increased from 20,000,000,000 tons.

It is almost incalculable the amount of traffic which is absolutely in the control of the American canal. I will give it as near as I can, so that we can appreciate its immensity. The trade of Great Britain with Ecuador, Peru, Chile, and Bolivia, which last year amounted to about $50,000,000, is absolutely tributary to this canal. The trade on the Atlantic and Pacific coasts is tributary to this canal, and amounted in 1890 to 80,000,000 tons. The trade of Belgium with Peru; the trade of our Atlantic ports with Hongkong, China, Japan, British Australia, Philippine Islands, and Sandwich Islands; with Chile, Peru, and Ecuador, which last year amounted to about $55,000,000; the trade of the Pacific ports of the United States with Belgium, France, Germany, Great Britain, with Cuba amounted to about $25,000,000, all together amounting to the vast aggregate of $130,000,000, not including the traffic between the Atlantic and Pacific oceans. There is also a vast amount of trade which is largely tributary to the canal, but this traffic is absolutely tributary to the canal. Its only passageway is through the canal.

Every economic and trade law demands that through this canal this vast commerce will go. Therefore, looking at this commerce as seeking its destination by the cheapest and quickest route, how can any sensible and disinterested person for one moment conceive that the traffic through this canal will be, as some wiseacres have put it, only to the extent of 2,000,000 tons a year? Now there is a large trade, a great part of which will go through this canal. It is not absolutely tributary, but part of it is almost certain to go through the canal. There is every reason to believe that a large amount of the return commerce between Great Britain and her Eastern colonies will pass through the canal. There is also a large amount of the English traffic returning from the East Indies, which, instead of going to London and being reshipped to New York, will be left at New York, and the vessel at this city will reload on its way to London. Such merchandise as plumbago from Ceylon, braid from China will be unloaded at New York and not sent on to London. The trade which I mention as largely tributary is the trade of Great Britain with Hongkong, New South Wales, Queensland, South Australia, Victoria, Western Australia, New Zealand, Tasmania, Java, Philippine Islands, China, and Japan. This trade last year amounted to $350,000,000.

There is to be added to this estimate the trade of France with Japan and Chile, which amounted last year to $23,420,000; the trade of Germany with Australia, $5,622,000; with Japan, $3,605,000, and Chile,

$26,439,000, which together last year amounted to over $35,000,000, and the trade of our Atlantic ports with the British East Indies, French East Indies, Dutch East Indies, and Central America, which together last year amounted to over $43,000,000. The whole amount of this last trade aggregates over $450,000,000, and a large part of this must, by the law of distances, seek its destination through the waters of this canal.

The trade of Chile, Peru, and Bolivia with England will take its course through the canal, as the journey between Bolivia and Liverpool will be shortened 4,099, and Valparaiso and Liverpool 2,144 miles.

Mr. JOY. Have you calculated how much tonnage will pass from west to east through the canal, from the Pacific Ocean through to the western coast of Europe, and the Eastern coast of the United States?

Governor MACCORKLE. Yes, sir; to some extent I have calculated the amount of traffic passing from the Western coast to the Eastern coast. The foreign commerce of San Francisco has grown to be as large as the foreign commerce of the United States between 1820 and 1830. The great disadvantage under which the Pacific Coast labors is that it is about as great a distance from the Pacific Coast—San Francisco, for instance—to Liverpool as it is to New York. The Pacific Coast has the finest timber in the world. This is becoming exhausted in the East, but we are compelled to have it. You have on the Pacific Coast 25,000,000 acres of splendid timber. Washington last year put out 1,800,000,000 shingles. It is too far to ship them around the Horn, and the railroad haul is too expensive. We need spar lumber and ship lumber, all of which must eventually come from the Western coast. In 1893 you shipped from Puget Sound 86,428,339 feet of lumber. About 12,000,000 of this went to Great Britain. Every foot of this lumber will go through the canal, as it costs from $10 to $11 by the Horn by sail and $20 to $25 by steam. The present capacity of mills of Puget Sound is 1,000,000,000 feet per annum. This will open up the greatest traffic on the Western coast in connection with the East.

Senator Squire estimates that the State of Washington alone has 200,000,000 tons of wheat per annum. There were exported last year from Puget Sound, San Francisco, and Willamette, Oreg., about 20,000,000 bushels of wheat. With the exception of about 150,000 bushels, this was all tributary to the canal. From the same towns there were shipped last year 1,300,000 barrels of flour. Every pound of this merchandise is tributary to the canal. Then, in considering the estimate which has been made of the Pacific Coast traffic by the promoters of the canal, we find that in the year 1894 the export of the articles of green fruit, dried fruit, raisins, and canned goods the estimate was much greater than was calculated. Senator White says that the State of California produced in these four articles alone last year 212,000 tons of freight. He also estimates that there were over 800,000 gallons of brandy shipped in 1894 from California, every particle of which will be tributary to this canal. The estimate of tonnage I have discussed in answer to your first question.

I have made some quite exhaustive investigation of this matter, but regret that to-day my time is so limited and I have only come prepared to discuss the question of coal in its relation to the Pacific Coast. It is utter and absolute nonsense, I submit, upon the facts and figures which I have here given you to estimate that there will be only about 2,000,000 tons of traffic through this canal. From every estimate which I have been able to make, it seems to me that there will be a safe traffic through the canal within the first two or three years of 5,000,000 to 7,000,000 tons, which, in a short time, will extend to 10,000,000 or

12,000,000 tons. This is a safe and I think conservative estimate. Of course I could give various reasons for this in the saving of distances, but the limits of my discussion to-day will not permit me. I think, however, that my estimates are on the side of conservatism and of sense.

Mr. BENNETT. What is your estimate of the tonnage from the Ohio Valley south, including coal, cotton, and other articles?

Governor MACCORKLE. Of course, the construction of the canal would stimulate all the productions of the South and the Ohio and Mississippi valleys. Our cotton is manufactured in England. We should send our cotton directly to its destination, but, as a matter of fact, we send it to Europe to be manufactured, and only get the price of the raw cotton. Japan is getting to be a great manufacturing nation. In a little while she will have control of the great part of the manufacturing of the East. She must get her cotton from us. In 1888 she bought 100,000 pounds; in 1891 she bought 7,000,000 pounds of cotton. She has more than 1,000,000 spindles, and her people all wear cotton.

We will be nearly 2,000 miles nearer Japan by the canal and 2,000 miles nearer the northern coast of China than England will be, so, as a matter of fact, the vast amount of cotton consumed in Japan should go directly through the canal. So it will be with a vast number of products of the Ohio and Mississippi valleys. In 1890 China imported 61,000,000 of cotton goods, and only 5,000,000 from us. China will have become a great manufacturing country, and within a short time a vast tonnage will be in that direction through the canal. The tonnage on the Mississippi River in 1890 was nearly 30,000,000. This will be increased vastly when we sell to the South American countries the amount of merchandise which our nearness to them demands that we should sell.

Including coal from the Ohio Valley Atlantic ports, I would estimate the tonnage of the Ohio and Mississippi valleys and the South at from two to two and one-half millions of tons a year.

When we discuss the Ohio Valley, we must take into consideration that this region from every consideration, cheapness of manufacture, locality, nearness to all the materials necessary to manufacture, splendid climate, facility for transportation, bids fair to be the great manufacturing region of North America.

We have right by us the splendid Bessemer ores of the Lake Superior Region, the largest deposits of splendid coals of every quality known to commerce. Upon the hills of the Ohio Valley we have the greatest body of hard-wood timber in the United States, while over a great part of its area are splendid deposits of red and brown hematite and red fossil ores of high grade needed and demanded in iron making, while above all we are in the temperate part of the United States, with none of the great fluctuations of extreme heat, or tremendous blizzards, or parched summers of many portions of this country. The fact is apparent that here in the Ohio Valley we are situated in the midst of the finest system of transportation on the face of the earth. From East and West, and North and South, the aim of capital has been to reach and cross over the marvelous wealth of this wonderful valley.

Our greatest need is that the products of our manufacture shall be allowed the cheapest and readiest connection with the markets of the earth. What has been known in the Ohio Valley, by reason of its teeming soils, its fertile valleys, and its fruitful hills, has been generally looked on throughout the world as a great farming and agricultural section, chiefly noted for its vast quantity of waving grain and all the various cereals of the temperate zone. While this is a marvelously rich section so far as the soil is concerned, and while only a few parts *of the world can compete* with it in the production of cereals, still no

section of the United States can in anywise compare with the Ohio Valley in the vast increase of its manufactures. In 1880 the manufacturing industries of the Ohio Valley were 89,000, while in 1890 they had increased to 115,000. The manufactured products in 1890 amounted to $3,300,000, about 40 per cent of the total manufactures of the United States, as against $1,791,000 in 1880.

Pardon a few more statistics in reference to this great valley. In 1890 the States of Pennsylvania, West Virginia, Ohio, Kentucky, Tennessee, Indiana, and Illinois had a population of 19,328,032, or 33 per cent of the total population of the United States. These are, strictly and technically speaking, Ohio Valley States. The States of Missouri, Louisiana, Mississippi, Arkansas, Wisconsin, Minnesota, and Iowa, which are indirectly dependent upon and contiguous to these Ohio Valley States, and are a part of the great Mississippi River system, had a population of 11,116,152 people, making in the two groups a total of about 51 per cent of the whole population of the United States, the entire population being 62,622,250. Out of the revenue collected in 1890, the Ohio Valley States paid between 30 and 35 per cent.

In the farm products of the Ohio Valley States, the census of 1890 shows that out of a total of $2,460,107,455 of the total value of farm products of the United States the Ohio Valley proper had about $655,985,797, or about 27 per cent of the total of the United States. The total value of the farm lands in the United States in 1890 was, in round numbers, $13,000,000,000; the value of the farm lands of the Ohio Valley group of States amounted in 1890 to a total of $4,730,000,000, or about 36 per cent of the total value of the farm lands of the United States. In the Ohio Valley the total value of farm implements in 1890 amounted to $148,000,000, in round numbers, or an increase over the Census of 1880 of 20 per cent.

The building of this canal will line the banks of the Ohio River from Pittsburg to its mouth with every class of manufacturing enterprise. It will cause, not alone the mere development of manufacturing industries within its limits, but the opening up of this section through cheap transportation to the markets of the world will necessarily demand the building of the ship canal from the Lakes to the Ohio River, in order that the cheap ores of the lake regions can be brought where they can be manufactured more cheaply than elsewhere. It will demand another vast improvement, to wit, the locking and damming of the Ohio River, so that at any season of the year the products of this region will not lie useless upon the banks of the river for nature to provide transportation, but through all seasons of the year, by reason of the great improvements made by our National Government in this river, our products may take wings and fly to other sections of the world.

This is not mere prophecy. The demand of the world for our products will be increased immeasurably when the world finds that here a great majority of the articles demanded by commerce can be more cheaply created than elsewhere, and the demand will be increased by the cheapness of the manufacture. Cheap transportation will be one of the great conditions of great sale.

Mr. NOONAN. I hope you will realize all you say, but do you not think you are rather optimistic in your views? About Asiatic labor in the production of coal—is not a contest going on there now between these people?

Governor MACCORKLE. Yes, sir; but, as I told you, we are mining coal nearly three times as cheaply as the Japanese.

Mr. NOONAN. Why?

Governor MACCORKLE. We have the cheapest coal and the most intelligent labor. Our coal is very much more easily mined and we have all the appliances to mine it with. Every condition with us in the production of coal is better than with them. It is true the Japanese are controlling the Hongkong market and driving England out of that market, but I have no question of our ability to successfully compete with them. They do not alarm us.

Mr. NOONAN. From your knowledge of the Japanese, do you not know they are very susceptible of improvement?

Governor MACCORKLE. They are going to be quite vigorous competitors, and for that reason we must have the most unrestricted means of competition. In my opinion, the most unrestricted means of competition is the cheapest communication. When we have that, I have no question of our ability to undersell and undermanufacture them in almost every field, with the exception of a few articles.

Mr. NOONAN. I think it resolves itself into this, that when it comes to cheap labor in this mining, then the Asiatics can beat the Americans all the time.

Governor MACCORKLE. They can on some few things. In reference to the production of paper, some of the cheap cottons, on some lines of pottery, and a few other of similar lines of articles, they can manufacture more cheaply than we can, but in any of the great lines of manufacture, in mining, in all of the matters which control the commerce of the world, man for man, our labor is twice as cheap as Japanese. I have shown this, I think, conclusively above in reference to the question of mining. We are mining coal cheaper than anyone in the world.

Mr. NOONAN. With the most intelligent labor——

Governor MACCORKLE. And therefore with the cheapest.

Mr. NOONAN. And possibly as soon as you get to running coal through the canal you will have a strike so you can not mine it as cheap?

Governor MACCORKLE. I do not know. I only know we are mining it cheaper to-day.

Mr. DOOLITTLE. I suppose machinery has become such a factor that it may largely control production?

Governor MACCORKLE. Yes, sir; that is the case. Within ten years machine mining will control hand mining, and outside of the cheapness of labor, man for man, the country which will be able most intelligently to use mine machinery will succeed in driving its rivals out of the field. Our people manage machinery better than any people on the face of the earth, and we are getting to use machinery quite largely in Pennsylvania and in West Virginia, and within ten years we will use it almost exclusively. It largely does away with manual labor in the mines. They have it now arranged so that they use a portable electrical apparatus near the mouth of the mine. We mine per man, in the New River field, 6 to 7 tons per day. With the machinery in the Pocahontas field the average amount of coal undercut per hour was over 20 tons. The conditions of mining in England and Germany largely prevent the use of machinery. Such is the case in Japan. The reason of this is that our veins lie in most instances above the surface, lie regularly and are easily accessible, and the machinery can be more cheaply used.

I would have been glad to have discussed generally the subject of the Nicaragua Canal but thought it best to confine myself to the great subject to which I have largely devoted my time.

I am very much obliged to the committee for its courtesy in listening to the matter so patiently.

The CHAIRMAN. We are very glad to hear you.

APPENDIX.

No. 80, BROADWAY, NEW YORK, *July 23, 1895.*

DEAR SIR: I understand from my recent conversations with you that your company will shortly be able to be in a position to proceed with the work of construction of the Nicaragua Canal. In accordance with those conversations I herewith make the following preliminary tender to you:

We should be willing to undertake the work at substantially the prices named for the different classes of work by Chief Engineer Menocal in his "Report on the final location of the canal," dated January 31, 1890, of which you furnished me a copy, with the following exceptions: We should want, instead of the prices given by Mr. Menocal, to be paid at the following rates:

1.	Clearing	per acre..	$150.00
2.	Rock excavation	per cubic yard..	1.80
3.	Earth excavation	do....	.50
4.	Earth fills	do....	.50
5.	Earth under water	do....	3.50
6.	Rock under water	do....	4.00
7.	Concrete in place	do....	10.00

The rest of the work described in Mr. Menocal's estimates we are prepared to execute at his figures, which, with the changes therefrom last above referred to, would make the total amount for which we are prepared to build the canal, $70,000,000.

This proposal is made in respect to the whole canal. It can be made to apply pro tanta to the eastern section thereof, from Greytown Harbor to the lake, thus excluding the work covered by the proposals which I understand you have already received for the dredging and for the construction on the western coast. I should prefer, however, to make one contract covering the entire work of the canal.

I shall be prepared to give satisfactory bonds for the faithful performance of the work within five years from the date of the contract.

It would be necessary for you to arrange that payments should be made monthly, either in New York or Greytown Harbor, upon certificates of work done or materials furnished, approved by the engineers of your company; and I am prepared to take these contracts for 50 per cent in cash and 50 per cent in bonds of the canal company, at such price as they may be issued to any other contractors or syndicate, or in any way disposed of by your company; or, if you choose, I am prepared to make the contract for cash, and I will contemporaneously agree to subscribe for an amount of the bonds in any syndicate which you may prepare, which will be equal to half of the amount to be paid me upon the whole contract, with its pro rata of stock.

I shall be prepared to enter into a formal and detailed contract with your company whenever you are in a position to satisfy me that your financial arrangements have been so far perfected as to insure the receipt by me of the cash necessary to be paid under such contract.

I ought to add that I am at present engaged under contract in the construction of a railway on the island of Jamaica, and I expect to finish that work about the first of the year. I am now employing there about 8,000 men with a large plant, and if any contract is to be made with you I should desire to have the same perfected before the 1st of December, if practicable, so as to arrange for the transfer of my force and plant directly from Jamaica to the isthmus. I feel safe in saying, if you can show me that your financial arrangements have been consummated, I should have no difficulty in putting a force of 25,000 Jamaicans alone at work upon the canal within ninety days from date of contract.

In accordance with our conversation, I have made this letter general in terms, but I think with the modifications of Mr. Menocal's figures above referred to, it is sufficiently specific to be the basis of a formal contract for the construction of the whole or a part of the canal, if you accede to my terms.

Yours, very truly,

JAS. P. MCDONALD & CO.

JOHN R. BARTLETT, Esq.,
President Nicaragua Canal Company, New York City, N. Y.

EARTH EXCAVATION ABOVE WATER, WESTERN DIVISION.

In the western division, where the rainfall, though much greater than in the United States, is much less than in the eastern division, the cost of the work is more nearly comparable to that of the United States.

The average contract price of earth excavation from the Chicago Drainage Canal is not far from 30 cents per cubic yard, or for clay alone about 25 cents per cubic yard. This work was executed mainly during the summer, because it could not be profitably carried on during the unfavorable weather of winter. Where the work was being executed, the banks of the canal were level, making it easy to move the plant for wasting the spoil, and, as noted by Mr. Bates in his interesting testimony, experience on the canal demonstrated that the two lines of railroad running on either side of the canal were of inestimable service. This, and the proximity to the almost limitless mechanical resources of Chicago, together with the extremely low price of fuel obtained from the vast coal fields of northern Illinois, in the immediate vicinity (delivered at $1.75 per ton), render the cost much less than that of similar work in Nicaragua.

The addition of 60 per cent to the cost of work at Chicago to meet the comparatively unfavorable conditions of climate, rainfall, cost of plant, fuel, and all other supplies in Nicaragua is an extremely moderate one. The figure adopted by the board, 40 cents per cubic yard, is the one which appears in the company's schedule of 1890, and is also the one adopted by Mr. Treat in his proposal to the company, although under certain conditions which practically amount to a large increase. In its recent estimate the company has reduced this unit figure to 35 cents for earth excavation from the canal, but has retained it for excavation at locks.

It is usual, in receiving proposals for lock excavation, to ask for a separate price for pumping. In the present case the cost of all auxiliary work is included by the company in the unit price for excavation, except in the case of the two tide locks, where specific allowance is made.

While in the board's estimate the entire cost of pumping and other auxiliary work is charged to excavation and taken up in the unit price, in this connection it may be well to note that, anticipating the difficulty involved in the construction of lock pits under heavy rainfall, the chief engineer, on page 89, states that it can be easily met by the construction of temporary sheds over the lock sites, but has not, apparently, undertaken to make an estimate of what it will cost to put under roof an area of 800 feet long by perhaps 100 or 150 feet in width.

The unit prices of recent excavations for dry docks in the United States may be interesting in this connection. At the Port Royal and New York docks the price was 60 cents per cubic yard; at the Puget Sound dock the price of the main pit was 50 cents per cubic yard, but greater prices for special parts of the work made the average price about 60 cents. In every case an additional payment was made for pumping.

EARTH EXCAVATION ABOVE WATER, EASTERN DIVISION.

It would be difficult to imagine more unfavorable conditions for excavating clay than exist in the eastern division under the tremendous rainfall of nearly 25 feet per year (in New York 3 to 4 feet).

The work in the east divide is through a continuous series of hills, and after the removal of the clay the profile taken on the surface of the rock will be only a little less hilly than before. The difficulty of handling plant under these conditions for the removal of material will be easily appreciated, and the addition of 50 per cent to the price adopted for the western division is not excessive. This unit price includes the cost of disposing of the flow of the waters of the Descado and Limpio, which cross the canal line frequently, and during the heavy rains have large volumes of water. The importance of this is very great, and the entire lack of data as to the actual volumes renders it impossible for an engineer or contractor to estimate closely the cost of doing this. The rains which occur nearly every day would cause the entire suspension of work of the same character anywhere in the United States. In ordinary work an inch of rain would involve temporary suspension and resort to pumping to clear the site.

The cost of earth excavation for the lock now in use at the St. Marys Falls Canal was over $1 per cubic yard, and the contract was profitable. The contract price for the lock about to be opened was 43 cents per cubic yard, and the contractors were in financial difficulty before the completion of the work.

MUD EXCAVATION AT SITE OF EMBANKMENTS.

The cost of this is estimated by the company at $1 per cubic yard, and by the board at $1.50. The figure adopted by the board was obtained by consultation with a

very competent contractor, Mr. Arthur McMullen, of New York, a portion of this unit price being made to cover the necessary cost of cutting off the mud bottoms above and below the site to prevent inflow into the excavation, a cheap and ready method of doing this being suggested as the sinking of rough timber cribs filled with stone into the soft bottom.

ROCK EXCAVATION, WESTERN DIVISION.

The company's price for rock excavation in the western division, according to the schedule of 1890, is $1.25 per cubic yard, reduced to $1 in their estimate of 1895, published for the first time in the report of the Board. The board has adopted the company's price of 1890.

The price adopted by Mr. Treat was $1.25, the same as in the schedule of 1890 and in the estimate of the board, but with certain conditions, which, as before mentioned with reference to the price of earth excavation, made a material increase.

The average contract price on the Chicago Drainage Canal was about 75 cents. The conditions under which this work would be done in the western division are much less favorable than at the Chicago Drainage Canal, for reasons before given, and for the additional reason that the material is largely hard volcanic rock, which breaks up much less readily, and where the cost of making the sides of the canal smooth, so as to be practicable for the passage of vessels, would be considerably greater. At Chicago, as is well known, competition is extremely keen.

On the eastern division the conditions are less favorable in every way, and the increase of 50 cents to the western division price per cubic yard is a very moderate allowance therefor. The economic methods developed at the Chicago Drainage Canal will be applicable here to a very small extent only. The average contract price of rock excavation at the Chicago Drainage Canal is about 75 cents per cubic yard. The rock is a soft limestone, horizontally stratified, which can be drilled easily, which breaks up well with explosives, and in which the sides can be made smooth cheaply by channeling machines. The ground is level, the rock being generally found at the surface, and the plant for the removal of the material is easily handled, to say nothing of the unusual and extraordinary facilities furnished by railways for furnishing access to the work on both banks.

The contract price for the large amount of rock excavation at the Jerome Park reservoir, New York City, placed under contract for the last year, is about 80 cents per cubic yard. The rock is a laminated gneiss, which would be somewhat more difficult to drill and blast than the limestone in the Chicago Drainage Canal, and less so than the so-called conglomerate in the east divide.

EARTH EMBANKMENTS.

The price adopted by the board and that adopted by the company in 1895 are the same, except that it was found that the excavation in the east divide would not supply a sufficient amount of clay for the embankments in the San Francisco basin. An addition was therefore made to cover the cost of excavating and loading on cars the required additional material. The company made no allowance for this unavoidable item of cost.

By building considerable additional railroad line a portion of this required material could be had from the several short excavations for the canal in the San Francisco basin, but the cost would probably be at least as much as by the method considered by the board.

The estimate for embankment for the San Francisco division in 1890 is 3,250,000 cubic yards at 30 cents. The company's 1895 estimate is over 6,000,000 cubic yards, using the same unit price, without noting the fact that the practical doubling of the quantity will necessitate borrowing to build the embankments. The board found it absolutely necessary to make an increased allowance to meet this additional cost.

ROCK EXCAVATION UNDER WATER.

The main body of this work must be done in the upper 30 miles of the San Juan River. The company's unit price for this in 1890 is $5, which they reduced to $3 in their revised estimate of 1895.

The cost of this class of work has been greatly reduced in recent years. The larger part of the work has been done by Mr. Charles F. Dunbar, of Buffalo, who is the inventor of devices by which a large reduction of cost has been effected. Considering Mr. Dunbar the highest living authority on this question, he was consulted by the board, and suggested the unit price of $5 to $6 per cubic yard for Nicaragua, and the board adopted the lower of his figures. Mr. Dunbar has recently authorized the use of his name in this connection.

The low price paid for this class of work under a current contract on St. Marys River, Michigan, viz, $2.43 per cubic yard, is not a criterion for the cost of work in

Nicaragua. The rock in the St. Marys River is horizontally stratified limestone, easily blasted and dredged. The work is done in a more favorable climate and in the neighborhood of all the facilities for the supply and maintenance of the plant.

In adopting the lowest figure named by Mr. Dunbar for work of this class, the board has gone to the lowest limit which it believed to be permissible under the circumstances, particularly as in the case of the St. Marys River the depth of excavation is only 22 feet, while in the San Juan River it is 28 feet and over, and the proper disposition to be made of the material arises as a question for careful consideration and may involve special arrangements for guiding the flow of the stream and the maintenance of the channel depth, resulting in a practical increase of cost.

LOCK CONSTRUCTION.

It is to be noted that the company's project makes use of no other material in the construction of the locks than concrete, if the estimates are to be followed in this respect. The various canal publications and statements indicate the use of ashler masonry to some extent, and other material which, however, are lacking from the estimates, which provide only for concrete at $6 per cubic yard. For example: Mr. Menocal's Chicago paper, pages 33 and 34, stated the body of the lock is to be of concrete, with cut stone in the miter sills, the hollow quoins, and such angles as need protection from shocks. Of all this nothing appears in the estimate.

The board has found difficulty in understanding what the company really proposed, as there are absolutely no detailed or construction drawings of any kind, and in forming its own estimate and computing the cost of these locks the board was forced to prepare for its own use preliminary drawings of this kind.

It is evident that the use of a resisting and massive material is absolutely necessary in lock construction, to take up the shock and friction due to the passage of large vessels, and the practice is universal of using either a very high order of brick masonry or the use of solid cut stone—limestone or granite of the toughest and most resisting kind.

The use of these materials is not only necessary in connection with the movement of vessels, but also to insure the solidity of anchorages for the gates and other appliances in connection with the operation of the lock.

The company disregards all these considerations and uses, exclusively, a concrete in the proportions, as stated by the chief engineer, of one volume of cement, two of sand, and five of broken stone, at an estimated cost of $6 per cubic yard.

Under the conditions existing in Nicaragua, where there appears to be an entire absence of stone suitable for ashler masonry, the use of concrete for the main walls of the lock is permissible, and was contemplated in the estimates of the board. Greater strength, however, should be given to exposed angles by the introduction of first-class stonework. The estimate of the Board covers the cost of this material for the hollow quoins only; that is, the portions of the walls in which the posts of the gates will turn. This is certainly the minimum amount of this material which should be used, and is much less than in any other known construction. Granite should be used for this purpose, and would have to be transported from abroad. The cost of this would be about $60 per cubic yard, which, of course, includes the expensive stone cutting necessary to adapt it to its uses and the special plant required for laying it in place.

It would probably be judicious to use the same class of material at the other exposed angles and for the miter sills, as specified by the chief engineer in his Chicago paper, but not provided for in his estimates.

In addition to this, in view of the unprecedented dimensions of the locks as proposed, and the uncertain nature of the material in which, of necessity, the locks must rest, and the possibility of the variation in the nature and supporting power of this material within the limits of the lock area, the board has considered the possible necessity of strengthening the lower portions of these structures by steel beams embedded in the concrete. This is especially important in view of the tendency of the middle of the lock bottom to rise in consequence of the great upward pressure from below which can not be counterbalanced by the empty lock.

It appeared to the Board that another considerable addition to the estimates was necessary to provide protection to the inner surfaces of the culverts for the admission to or discharge of water from the lock. This might be provided by a lining of hard brick, or by a metal lining. The estimates of the board provide for the latter.

Mr. Wheeler, the superintending engineer at the St. Marys Falls Canal lock, in his article on lock construction in the Engineering News of June 2, 1893, makes a total estimate for a system of six locks at Nicaragua, each of 36 feet 7 inches lift, amounting to $1,000,000 for each lock at United States prices, and on the assumption that the lock is to be built on a rock foundation. Starting with this figure of $1,000,000 for the lock itself, adding $400,000 for additional concrete, to constitute a lock foundation in lieu of the rock considered by Mr. Wheeler, makes $1,400,000 at United States

prices. This total needs translation into Nicaraguan prices, for which an additional allowance of not less than 50 per cent should be made, making the Nicaragua cost of the lock, exclusive of excavation of the lock site, $2,100,000, making a total of $6,300,000 for the three locks of the eastern division, with which may be compared the total in the company's estimate of $3,236,000, which the board believes should be increased by the substitution of four locks for three, with a corresponding total of $7,000,000 as the additional allowance of 50 per cent for different conditions in Nicaragua may easily be increased.

CANAL AND CHANNEL DIMENSIONS.—LOCKS.

The 1890 estimates were based upon a lock width of 70 feet. The next announcement of the width occurred in the chief engineer's Chicago paper, in which he states that the width has been increased to 80 feet. In his recent testimony, on page 73, he finds no objection to this increase from 70 to 80 feet, except the cost. On page 86, referring to paragraph 12 of the board's report, in which they expressed the belief that all locks should have a width of not less than 80 feet if it be intended to provide for the passage of war vessels, the chief engineer condemns this suggestion as objectionable, and he regards it unnecessary to charge the enterprise with an excess of cost above that required for commercial purposes in order to permit of the passage of a few war vessels. This width of 80 feet announced in his Chicago paper in 1893, has been repeated in all recent publications of the company, and is now repudiated and condemned.

The board adhere to its belief that 80 feet should be regarded as a minimum width, in view of the use by the United States Government of the canal to facilitate the movements of its Navy and the control of the work in case of war.

On pages 58 and 65 of his testimony the chief engineer mistates the dimensions of the Suez Canal. He gives the depth at 26 feet, and the width as less than 100 feet. As a matter of fact the least depth in the Suez Canal at this time is 27 feet 10 inches, and for the most part it is 29 feet 6 inches, and the administration proposes an ultimate depth of 32 feet 10 inches.

The canal, as constructed, was 72 feet wide, with passing places excavated at intervals in the bank. These passing places have since been eliminated by the widening of the canal to 110 feet, this widening having been completed with the exception of 10 or 12 miles out of the 100. It is to be noted, however, that even with this widening vessels are not permitted to pass each other underway. When two vessels meet one must go to the bank and tie up while the other moves safely by.

In order to provide for the free navigation of the canal and expedite the movements of ships by rendering it unnecessary for them to stop, the administration, in connection with the increased depth to 32 feet 10 inches, provides for a widening to 216 feet on the straight stretches of the canal and on curves to 242 feet, these widths being measured on the bottom of the canal. With these widths the company believe that the navigation will be free and unobstructed.

These dimensions are to be compared with the proposed dimensions of the Nicaragua Canal, with bottom widths in various sections ranging from 120 feet in the sea-level portions to 100 feet, with vertical sides in the rock portions, and 80 feet at several minor isolated sections. The depth is stated as 30 feet, except in the sea-level sections and in the river, where for 30 miles it is to be 28 feet. From these depths, however, as has been previously noticed, must be deducted the variation from what the chief engineer calls the "average summit level," to provide for the vertical oscillations of the lake surface. He estimates these oscillations, in one case, at 3 feet, in another portion of his testimony at 4 feet, and in another place states that the range of the lake has been noted as 10 feet.

The board has found reason to believe that the lake has varied so much as 14 feet; Menocal admits 10, but no systematic observations have ever been made to determine the lake regimen, upon which depends that of the river.

With a range of 4 feet the 28-foot river channel becomes but a 26-foot channel, in which, allowing for 2 feet as a minimum below the keel of a vessel, nothing deeper than a 24-foot ship can pass. Should this range amount to so much as 5 feet the maximum depth becomes 23½ feet. If it be found impossible to control the oscillations of the lake within less than 10 feet the reduction in depth in the channel will be 5 feet, and nothing deeper than a 21-foot ship can pass. In each of these cases the channel would be impassable for heavy war ships, as well as for trading vessels, the increasing dimensions of which experience has shown can be more economically run with large dimensions than with smaller.

In the case of the Suez Canal, with the minimum depth of 27 feet 10 inches now existing, the maximum draft of vessels permitted in the sandy bed of that waterway is 25 feet 7 inches, leaving 2 feet and 3 inches between the keel of the vessel and the sand bottom.

Objection is made to the board's suggestion that the width of the deepened channel in the river should be increased from 125 feet, as the company proposes, to not

less than 250 feet, with additional widening in the bends, and the chief engineer contends that in our consideration of this subject we have been misled by our acquaintance with the requirements of the lake navigation, with which, apparently, he believes that of the Nicaragua Canal is not justly comparable.

As stated in the board's report the minimum width for the river and lake channels on the lakes is 300 feet, increased in places to 500 and 600 and even 800 feet. It should be observed that these dimensions were fixed, not recently, but many years before the lake traffic had attained its present proportions, when the vessels were much smaller than now, of less draft, and therefore more manageable in a narrow channel, and as a whole very much less than the traffic which it is proposed to provide for in the case of the Nicaragua Canal.

The St. Claire Flats Canal, which forms the exit from the St. Claire River into the lake, a work designed and executed thirty or forty years ago, has a width between banks, which are laid out straight and built of timber, of 295 feet, and between these vessels are restricted to a speed of 5 (!) miles an hour, and are not permitted to overtake each other. It is quite certain that in the case of the Lake Nicaragua channel, built as proposed by the company, without constructed banks, no less width than 300 feet can by any possibility be estimated for, and the maintenance of this or any navigable width will require the continual use of a dredging machine for maintenance.

The company in its reference to this obscures the subject by calling these river channels canal, with which, as a matter of fact, a deepened river channel without banks can not, in this respect be compared, and it is to be observed that the width of river channel proposed by the board is little in excess of that which the intelligent and experienced management of the Suez Canal believe to be necessary for an inclosed channel with soft bottom and well-defined banks and no current.

With reference to the width of the lake channel, which the company now and again terms canal, the board believes that it has adopted an equally sound and conservative view, nor is it believed that on Lake Nicaragua, or in any similar situation, a channel of 14 miles can be laid out in the open lake through the material which it is known forms the bottom of the lake with any less dimensions than those which the board has recommended.

The material has been described as soft mud, ranging from a thick pea soup at the top to stiffer material below, and it is not believed, as before stated, that even Mr. Bates's magnificent hydraulic construction could make a cut through that 14 miles and be able to find it had been done.

The most recent proposition in this country for providing an exit for commerce by water from the lakes to the sea, it may be noted, projects a channel with a minimum width of 300 feet.

STATEMENT OF CIVIL ENGINEER MORDECAI T. ENDICOTT, UNITED STATES NAVY, LATE A MEMBER OF THE NICARAGUA CANAL BOARD.

Mr. CHAIRMAN AND GENTLEMEN OF THE COMMITTEE: In accordance with the understanding at the time when my oral examination before the committee closed I submit herewith a few statements pertinent to some of the criticisms made before you of the report of the Nicaragua Canal Board of 1895.

When Mr. Noble and I appeared before you at that time, at your request, the examination took directions leading to many of the points with respect to which the correctness of the report of the board had been questioned or sought to be disproved.

I shall avoid useless repetition of anything then said, or of what Mr. Noble has embodied in his written statement, and omit replies to criticisms which are of little weight or relate to matters of minor importance, confining myself to a few matters which seem to me to be of sufficient importance to be called to the attention of the committee, and which were not previously stated by me because of the press of time, and also because I had not then had time to read over carefully all of the testimony given up to that time, April 17, 1896.

GREYTOWN HARBOR.

In my oral testimony before the committee in regard to the Greytown Harbor I explained briefly the reasons why I considered the plan and location proposed by the board as superior to that of the canal company.

It is stated in Mr. Menocal's testimony, page 71, that the board accepts as correct the principles on which the plans proposed by the canal company for the restoration of the harbor are based. This is correct only in so far as it relates to the construction of a pier, seaward, for retarding the filling of sand at the mouth of the harbor.

The principal upon which Mr. Menocal builds, as stated in his description of the Nicaragua Canal project, read before the World's Columbian Water Commerce Congress, Chicago, 1893, and in numerous other papers and reports, is that the harbor will be restored by building a jetty perpendicularly to the shore line, projecting seaward about 2,000 or 3,000 feet to the 6-fathom curve, and dredging in its lea.

The shifting sands, arrested by the jetty, are to gather in the east angle formed by it and the coast, and when it has advanced to the end of the pier, with a tendency to move around it, short extensions from time to time can be made, until the new coast line on the east becomes, in its general direction, perpendicular to the prevailing northeast winds, when "no further change on the coast need then be apprehended and the permanent restoration of the harbor will be accomplished."

This principle the board has not accepted, as I understand.

To put out a jetty to reach a point from which a line drawn normal to the northeast winds would approximate a direct extension of the coast line, within which I think the attainment of such a line of fill is exceedingly problematical, would require the jetty to be about 3 miles in length. This would entail an extraordinary expense—make the cost greatly more than a harbor in the location recommended by the board, and, in my opinion, there is no assurance of permanency when that length be reached. The investigations of the board show a wasting of the coast to the eastward and a filling to the westward, and in the bight of which the Greytown Harbor was originally a part.

The neutral point between these, where there is at present a more nearly stable condition, is about where the pier or jetty and the harbor mouth are recommended to be established by the board. At this point deep water is much nearer, and if a point is within reach of a jetty, where the new east coast line will stop the drift of sand, it will be found here at one-third of the distance necessary in the location by the canal company. The sands drift into the Greytown bight from the north as well as from the east, and the company has placed its works right in the spot where they have to contend with these forces in their greatest strength, because, as stated by Mr. Miller, they "naturally supposed that a good place to make an entrance to a harbor would be where one existed many years before."

I think the bight will be destroyed inevitably, and an entrance at the point proposed by the company can be kept open only by dredging and annual extensions of the jetty to an extraordinary length.

I see nothing in the results attained when the present pier was constructed to augur permanency of entrance or restoration of the harbor. It only shows what could be attained if the drifting of the sands across the entrance could be permanently arrested. How far a jetty or pier would have to extend to effect this, if at all, was not demonstrated.

The location proposed by the board will be found, I am confident, to be the cheaper for a harbor of the same character and amplitude, taking into consideration its future maintenance.

Of the objections to the plan recommended by the board, Mr. Miller and Mr. Menocal regard one as conclusive, namely, that it locates the entrance in Costa Rican territory.

Mr. Miller, on page 12 of the testimony, states: "In reference to the entrance to the harbor being moved a mile and a half east, I would say that, in the first place, we could not go there. If we went there we would be in Costa Rican territory and our concession *demands* that the canal shall begin and end in Nicaraguan territory." Mr. Menocal, on page 71 of the testimony, states: "The Government of Nicaragua will not assent to it. The canal concession provides that the company *shall* build one first-class harbor on the coast of Nicaragua at each terminus of the canal, on the Atlantic and Pacific oceans."

The concession from Nicaragua, of 1887, as printed in House Report No. 1201, Fifty-third Congress, second session, states in the decree, on page 23, "both having sufficient powers, have entered into the following contract for the excavation of an interoceanic canal through the territory of Nicaragua."

In Article XVI, on page 26, it states:

"The company shall construct, at its expense, and maintain in good condition, two large ports, one in the Atlantic and one in the Pacific. * * * It *may*, for this purpose, select on the coasts of the two oceans, within the territory of Nicaragua, the localities which the surveys may indicate as preferable."

In the contract with Costa Rica of 1888, confirmed more than one year subsequent to that with Nicaragua, it is provided in Article XIV, page 38, of the same report, No. 1201, as follows:

"The association shall construct, at its expense, and shall keep in good condition, two large ports, one on the Atlantic and one on the Pacific, at such points or localities as it may select *within* or *without* the territory of Costa Rica, to serve as termini of the canal."

All the italics are mine.

These provisions do not seem to me to demand that the ports or termini shall be within Nicaraguan territory. They appear to me to provide simply that they may be. But this may be a matter for legal construction.

DREDGING AT GREYTOWN.

Considerable effort has been made to show, during the hearings before your committee, that the estimate of the board of 25 cents per cubic yard for the dredging in Greytown Harbor, is excessive.

As explained in the report, this estimate is based upon 20 cents for the interior work and 40 cents for work in the entrance, an average of 25 cents being used.

The dredging in Mobile Harbor, now being done at a cost of 7⅞ cents per cubic yard, is most dwelt upon as evidence of an excessive estimate.

The cost of all dredging is dependent upon the conditions obtaining at each situation, else why does it vary in this country from a few cents to 60 cents per cubic yard? To say that a cost of 7⅞ cents at Mobile should govern an estimate at Greytown, without considering the relative conditions, is no fairer than it would be to claim that the cost of dredging at Galveston, at 60 cents per cubic yard, within the past fiscal year, should determine an estimate of 60 cents for dredging in Greytown Harbor.

The material in Mobile Harbor being removed for 7⅞ cents per cubic yard is classed as 90 per cent soft clay—river mud. It is ideal dredging, exactly adapted to apparatus used—clam-shell dredges. The machinery is simple, easily and cheaply kept in order; the fuel is cheap; the labor is cheap; the situation, a smooth interior harbor; the depth, extreme, 23 feet; in short, everything favors small cost.

Another contract in same harbor, completed just as the above began, in material 60 per cent sand and 38 per cent clay, was at 15 cents per cubic yard, and one for material 81 per cent sand was for 16¼ cents.

At Galveston the prices have been, within a very recent period, 12½ to 60 cents, the dredging on the bar being 35 cents, all scow measurements.

In Mobile the 7⅞ cents contract is for the mud measured *in scows*. It probably measures somewhere from 30 to 40 per cent more in scows than in the cut.

The dredging at Greytown is estimated *in the cut*, neat dimensions, and the material is *sand*.

Add to the price for mud dredging at Mobile at 7⅞ cents, 35 per cent for measurement in cut over measurement in scows, a proper increase for sand over mud, a proper increase for a depth of 30 feet over one of 23 feet, also increases for cost of fuel, skilled labor, the establishment of a repair-shop plant in Nicaragua, unfavorable climatic conditions, etc., and it must be seen that the price of the inside work would cost 20 cents per cubic yard, as estimated by the board, upon the basis of the work now being done at Mobile.

The board estimated 40 cents for outside work, also measured in the cut. It is costing 35 cents at Galveston, measured in scows.

The above work, instead of vitiating, really warrants the board's estimate, and serves to point the error of drawing conclusions from prices paid at a particular point without careful consideration of all the circumstances.

The board took into view all the conditions and endeavored to arrive at a fair and reasonable estimate.

BENARD LAGOON.

With regard to the change of location of the line to avoid the Benard Lagoon, this is only a suggestion of the board in case examinations of the lagoon develop conditions indicated at the entrance.

The possibility of finding the conditions feared by the board is not a remote one If they are found we think the line should be changed to avoid it. Our estimates, however, are not for a change of line, but for the present location of the company.

OCHOA DAM.

In oral testimony before the committee, and in his written statement, Mr. Menocal makes a very elaborate defense of this dam, as it was proposed to be built by the canal company, and attempts to show that the difficulties and dangers in its construction and use, as set forth by the board, are without foundation.

The estimate submitted to the board by Mr. Menocal when it was making up its report last fall, in New York, was, for this dam, $977,273, which was $250,135.50 in excess of the last previous estimate of the company.

In his present testimony, besides commenting adversely upon the board's views as to the then proposed structure, he characterizes the estimate of the board for this work, which is $4,000,000, in the following words, on page 64: "I regard the estimate

of $1,500,000 for strengthening the dam as a gross exaggeration, and I regard the other estimate of $1,500,000 to take away the flow of the river during the construction of the dam as dangerous and likely to lead to disaster."

Now, referring to his testimony on page 60, he states, describing the dam, "I propose to give it a base of about 1,000 feet" (in the description of the dam given by him to the board under date of September 14, 1895, he states this dimension will be probably from 400 to 500 feet), and on page 57, in reply to an inquiry as to what he estimated the cost of the Ochoa dam, he is said to have replied, "inside of $3,000,000," which, as I now understand, he has corrected to $2,000,000. If these latter statements indicate anything it is that since the board made its report as to the proper dimensions and cost of this structure he has doubled the width of the base and increased its estimated cost from about $1,000,000 to about $2,000,000. Yet the board's estimate of $1,500,000 to strengthen it is a gross exaggeration, notwithstanding he seems now to estimate $1,000,000 for that very purpose.

Notwithstanding his strenuous opposition to the views of the board in respect of this structure he seems to have concluded to follow them somewhat closely in the matter of what its dimensions should be, and the canal company is to be congratulated upon this step in the right direction, if this apparent change of mind of Mr. Menocal means that the company's project has enjoyed a similar alteration.

As Mr. Menocal's testimony develops that he is not now, and never has been, the engineer of the Maritime Canal Company, and is not now the engineer of the construction company, it is not known whether his present statements as to what he would do are to be regarded as a change of the project of the Maritime Canal Company. When Mr. Menocal presented to the board the maps, data, and project of the Maritime Canal Company the board had that company's authority to receive them as authoritative. Whether in his statements before your committee he represents the Maritime Canal Company, the construction company, or himself, I am not advised.

In any event, so far as the merits of the review of the Maritime Canal Company's project by the board is concerned, they are to be considered and discussed as upon the plans and projects as they existed when the board considered them and made its report, and not upon what Mr. Menocal now says, in the light of the Board's criticisms, he would make them.

In the present defense of what the company proposed or he proposes to do at Ochoa, Mr. Menocal relies with most stress and particularity upon experiences in India in the following words: In searching for precedents of rock-fill or dry-rubble dams built on sandy bottom to withstand the flow of large volumes of water over their tops, we will have to look at the irrigation works of India, where such methods of construction have been in practice for many years," etc.

I acknowledge the richness of the field in India for the study of all that relates to works of irrigation and the storage of water by means of dams; and in the search for examples illustrating the application and effects of principles underlying the construction of dams, while investigating the problem at Ochoa, I found it a most fruitful and fascinating field; but I do not now recall a single rock-fill dam, as understood in this country, and proposed at Ochoa, in all India.

Let us see what are the structures referred to, and of which five are specifically cited and described by Mr. Menocal on page 75, and upon which he relies, with similar others, as precedents for the success of the Ochoa Dam as intended.

Maisur.—Reference is first made to "rough stone weirs at the heads of most of the irrigation channels in Maisur, which raise the level of the water to the required height, the lowest being 7 feet and the highest 25 feet."

It will be interesting and valuable to quote the description of these same works by an English engineer of experience in India, as follows:

"The ordinary stone dam or anicut in Maisur varies from 7 to 25 feet in height. It consists of a mass of dry rubble, faced with large stones, placed on a rocky site, the front casing of stones 3½ feet by 1½ feet by 1 foot, the rear aprons of large stone blocks 9 by 3½ by 2 feet, each stone projecting for one-third of its length beyond that above it, or about 2½ feet. The interstices are filled with small rubble. These works are unstable and leaky, allowing all the summer discharge to escape, and only supplying the channels in seasons of flood, when again they are easily damaged and breached. The dams are curved and point upstream, having a length about double the width of the river. The crown is lower near the head sluices to relieve the pressure against them in flood."

Wilson, referring to these rough stone weirs at heads of channels in Maisur, says: "These illustrations gave a fair idea of the attention given by the natives to this class of work, and indicate the fallacy of trusting to size and position of the material instead of to the homogeneity of the work. Notwithstanding the employment of large blocks of stone and skillful application of material, the dam was breached five times between 1842 and 1863."

Mudden.—If the "Mudden" weir referred to in the next paragraph is the "Mad-

dur" of the same district, it also is founded upon rock. It is to be observed that it was reconstructed and a brick and mortar wall introduced across its upper face.

Agra.—The Agra weir is cited as representing a quite usual type of rough weirs built in sandy bottoms, with crest 10 feet above river bed, and length of 2,575 feet. The flood discharge is said to be as high as 1,300,000 cubic feet per second, and the depth of water over the crest about 10 feet.

The history of this weir is most interesting and instructive, and I therefore give space to a brief description of it and its vicissitudes.

This weir is said to have the greatest width in cross section of any weir in India. As finally constructed, for it went through various stages of design, it is described by several authors as having first, two longitudinal solid masonry walls extending to the bed of the river, about 30 feet apart. About 40 feet below the second wall is a third, 4 feet 9 inches high.

The upstream slope is hand packed and laid dry. On the downstream slope the intervals between the walls are filled with large rubblestone, and very carefully dry parked with very large rubble on top. The rubble used in the packing is very large, some stones being as much as 6 feet by 3 feet by 2½ feet, the walls acting as bars to prevent them sliding.

There are 16 sluices in this weir, each 6 feet wide by 10 feet high. The crest of the weir is 10 feet above the floors of the under sluices. The weir and under sluices are founded upon the sandy bed of the river without any foundation below. The head sluices are founded upon blocks or wells sunk to depths of from 9 to 20 feet and hearted with concrete.

The construction of this weir was begun in 1870, but it was very badly damaged before its completion by a flood which nearly carried away the head sluices and scowed out a hole 50 feet deep at the end of the floor. The velocity over the crest of the weir at this time was 9.3 feet per second, and was estimated to be 18 feet per second some 60 feet below the crest. During several successive years the lower end was carried away, and changes each year made in its design and construction, until in 1875 it had been built of such form and dimensions and by such method as enabled it to withstand the floods. The flood action on the rear slope, although 1 in 20, is very severe. Even in its final shape engineers have expressed doubts of its stability.

The accompanying plan shows the successive changes in construction it underwent to enable it to withstand a flood, much less stressful, as we shall see, than those the Ochoa Dam is likely to meet. It will be seen that its first construction, in 1870, was much superior to that proposed at Ochoa, not only as related to the duty to be met, but per se, and yet it was inadequate; and it underwent various changes, each one of which was a still greater departure from any semblance to the contemplated Ochoa Dam, and its final outcome is a hand-made weir of the most careful and substantial construction, which, since its final reconstruction in 1875, has apparently stood without serious injury.

Mr. Menocal states that the flood discharge is as high as 1,300,000 cubic feet per second, the depth of water over the crest being 10 feet.

If this amount of water flowed over the dam, of the depth stated, the velocity would be about 50 feet per second, or over 34 miles per hour. This seems almost incredible. In the flood of 1871, when it was partially destroyed, the velocity over the crest was only $9\frac{3}{10}$ feet per second.

It is probable, therefore, that the statement of Mr. Buckley (who is an authority upon irrigation in India) that the discharge of the river in high flood is only about 150,000 cubic feet per second is the correct one, and the sluices, to which no reference was made, pass a considerable portion of this.

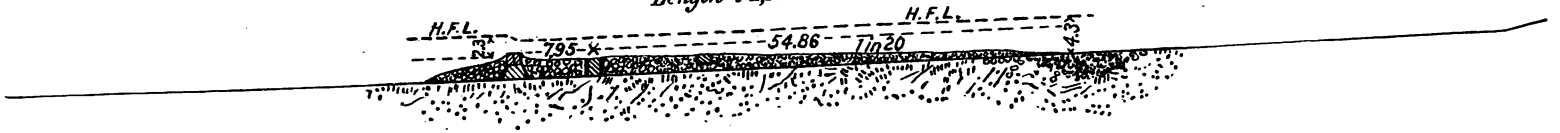
Here is a low wier, only 10 feet high, with a long, flat slope of 1 in 30, begun and built in the dry, with a masonry crest wall extending down to the river bed, with carefully packed surface of heavy stone, unable to stand the flow of 150,000 cubic feet per second, precisely the flow which the board attributes to the San Juan at Ochoa, but spread out in a thinner sheet, and which Mr. Menocal, in his third answer, on page 64, calls an insignificant stream. It was so badly damaged year after year at flood seasons that it took the dry seasons of five years to gradually strengthen it with additional masonry, cross walls, and heavy and substantial hand-packed paving to bring it up to a condition of comparative safety.

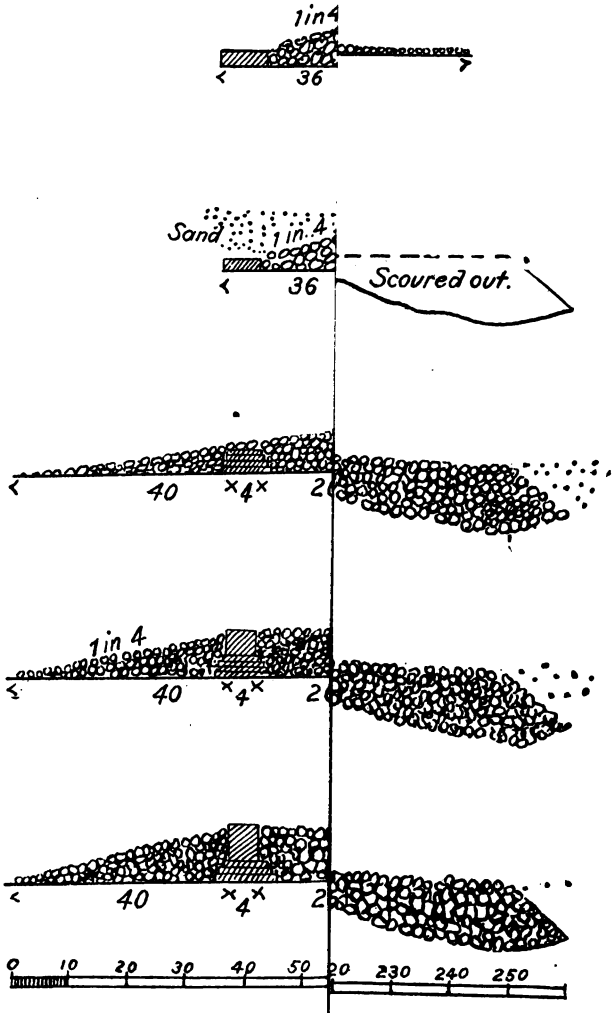
According to the theories advanced in behalf of the canal company's methods in the fourth and fifth paragraphs of page 76 of testimony, this was all wrong; and instead of building and reconstructing this weir in the dry seasons, with the water off, and by substantial and careful handwork after the design described, they should have done nothing in the dry seasons, but carried on operations only in the floods by dropping loose stones on the site for the floods to dispose in their proper resting places.

Soane Weir.—The weir next mentioned by Mr. Menocal is the Soane, which he describes as being similar to the Agra, previously described, and as resting on wells *sunk from 6 to 8* feet in the sandy bed of the river, three masonry walls being used to

OKHLA WEIR–AGRA CANAL.

Length 74,3 metres.




1 in 4
36
Sand
1 in 4
36
Scoured out.
40
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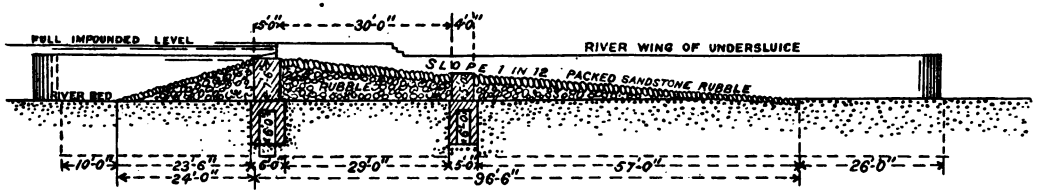

SECTION OF THE SOANE WEIR, 12,469 FEET LONG

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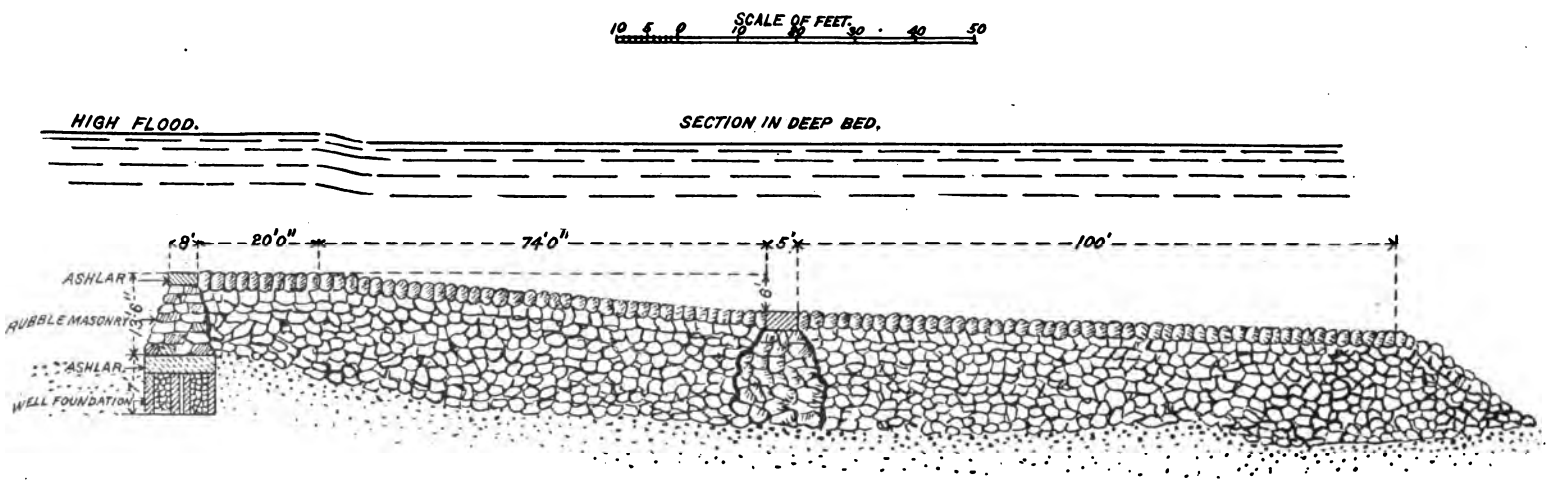
KISTNA WEIR (BEZWARA)



S. Rep. 1109——54—1

keep the small stone in place. Between the walls is a simple stone packing. He gives the height, including depth of wells, as 19.3 feet, and flood discharge 750,000 cubic feet per second.

The above description is apparently derived from Mr. Wilson. Other authors give the depth of the foundation wells as 10 feet. The spaces between these foundation wells are filled in with concrete, making a continuous foundation extending further below the bed of the river than the top of the weir rises above it. The height of the crest of the weir is only 8 feet above the river bed.

The paving between the masonry walls is hand-packed and laid dry with large rubble stone. The down-stream slope is very flat—1 in 20. The entire remaining portions of the weir consist of large stone blocks dry packed, the masonry walls acting as bars to prevent sliding. Further, the weir is pierced with three sets of sluices, with a total of 56 openings of 20 feet 7 inches each, which pass a considerable portion of the floods. One important office performed by these undersluices is found in that the discharge through them helps to fill up the river channels below in rising floods, and so reduces the action of the floods on the weir itself. The weir becomes submerged before the flood attains its greatest height, which is 8 feet over the crest, with an afflux of only 15 inches.

If the important modification of the stress on the weir effected by the 56 sluices were disregarded and the entire extreme flood were supposed to pass over the crest, the velocity would be only about 10 feet per second on the crest over a submerged weir, but the sluices pass about one-third of the flood. The banks of the river are hard soil with some nodular limestone mixed with it.

"In order to prevent the destruction of this weir by the action of flood waters, groynes of a peculiar shape, called alligator groynes, are constructed on both the up and down stream sides at intervals across the channel."

Professor Davidson states that "notwithstanding the good workmanship and apparent security of the foundation for the scouring sluices, the floods of 1874 proved very destructive, and not only tore away the river bed to a depth of 38 feet below the toe of the talus, but in part tore away the heavily packed interspace between the lower wall and that next above, and even partly damaged the wall. * * * The river bed scoured out above as well as below. * * * The action is very similar to that at the headworks of the Agra Canal."

Bezwada Weir.—This is the fifth and last of the Indian weirs adduced as examples or precedents of rock-fill dams.

This weir is founded on a double row of wells sunk 7 feet into a sandy bottom. The sandstone runs down to the river on each side of the weir. On the foundation wells there rises a massive wall of rubble masonry 13½ feet high, 12 feet base, and 6 feet top, coped with ashlar. Behind this wall a mass of rough stone of all sizes up to 5 and 6 tons in weight was deposited. At 100 feet back another wall was built, it being 6 feet below crest of the weir.

Between the walls the surface of the weir is packed with the largest stones placed on end, the interstices being filled as far as possible by quarry shivers jammed well into them. Behind this second wall the apron of the weir is continued for about another 100 feet with large stones, the slope about 1 in 16. At high flood, although the water flows over the crest 20 feet deep, the weir is submerged, and the water flows over with scarcely a ripple on the surface. One year ago a short length of the body wall was torn away.

Temporary dry stone walls, 4 feet high, were annually built on the crest for the purpose of diverting more water in the dry season, and after the stone had been washed off by the floods they were used in the repair of the apron. This shows that the massive and heavily paved slope is damaged in floods and that repairs are made every year when the work is dry.

The entire flood of 736,000 cubic feet per second mentioned does not all pass over the weir. It is to be noted that this weir has undersluices, with 60 openings 6 feet wide each, which pass a large amount of the water and help to fill up the channel below as the floods rise, and make the weir a submerged one early in the flood.

I have been somewhat full in the description of these Indian weirs, because they are presented by Mr. Menocal (p. 75) as examples of rock-fill dams, and precedents for the construction proposed by the canal company at Ochoa; and by Mr. Miller (p. 14) as being built in the same manner.

As already stated in my testimony before the committee, I believe that a rock-fill dam can be successfully constructed at Ochoa, and the report of the board states as much.

I do not approve, however, of the attempt at the construction of this dam by the methods proposed by the construction company, exposed to the entire flood discharges of the river, and its use for the purposes of a weir after completion.

Viewed as examples of and precedents for such construction and use these Indian weirs are failures. They are not the same kind of structure and do not perform the same office.

In the first place, the Indian weirs are not to be considered as storage dams. Some of them may, indeed, perform that office for a short time in the dry season. They are built as obstructions, to slightly elevate the river surface and divert a part of its flow into irrigation and other channels.

The indiscriminate use of the term "weir," as descriptive of the Ochoa Dam, and of the term "rock-fill dam," as applied to the Indian weirs, must not cause the mind to lose sight of the great and important distinction between these two classes of structures, by which it is sought to present the sometimes successful and sometimes disastrous low and carefully built submerged weirs of India, as promises of safety in a high rock-fill storage dam at Ochoa to be built and used in a hazardous manner and which is to be the keystone of a project to cost, perhaps, $150,000,000.

The failure of this dam would liberate the largest quantity of water ever set free at once in the history of the world.

I do not think there is a single rock-fill dam in all India, or a single permanent rock-fill weir, even, in the sense of a rock-fill as intended at Ochoa.

There are, indeed, in the head works of the Ganges, three Weirs, built of rough bowlders, crossing the river one behind the other, but these are temporary, being destroyed each year by the floods, and it has been found necessary to rebuild them annually, new bowlders being brought down for the purpose, as the old ones are carried too far away when the dams are wrecked to be economically collected.

Mr. Wilson states "only rarely are temporary weirs constructed simply of loose bowlders." They are almost always constructed substantially of masonry, and are well founded.

The plans which I have introduced in this text will serve to show more clearly the careful construction of the Indian weirs quoted, their low height, and consequent light-water pressure, their long easy slopes, and the fact that they are in high floods *submerged* weirs, their slopes enjoying this condition as well as the masonry walls and heavy carefully packed paving to protect them.

The Ochoa Dam would be submerged in its earlier stages of construction, but not in the later, and never after completion. Its slope would be of stones deposited at random, without cross walls to protect it, and three-fourths of it exposed at all times to the unobstructed rush of the waters down its steep declivity.

In the construction of the Indian weirs a velocity of 15 feet per second on a flat slope is regarded as a maximum. The velocity down the improved rear slope of the Ochoa Dam, during the company's construction, is quite certain to reach 25 feet per second, perhaps very much higher.

The canal companies have no plan for the Ochoa Dam, so that I am unable to introduce one, but I have shown its outline as indicated by the written descriptions furnished to the board, and superimposed it on the Agra weir, with which it is most closely compared by Mr. Menocal.

These plans also show more clearly to the eye the great difference between an Indian weir and the Ochoa Dam, and that they have little in common in construction, dimensions, steepness of slope, height, head of water to be resisted, and exposure of slope to the action of floods.

So far are they from being examples promising success, that at least two of those cited by Mr. Menocal, from the testimony of authors conversant with them, are striking warnings of the dangers of the particular methods intended by the canal company.

Of the Indian weirs, many are built to be destroyed every flood season, and to be rebuilt in the dry season. Others are built to be partially destroyed or damaged every flood, and few escape injury.

These conditions must not obtain with the Ochoa Dam.

Too much depends upon it.

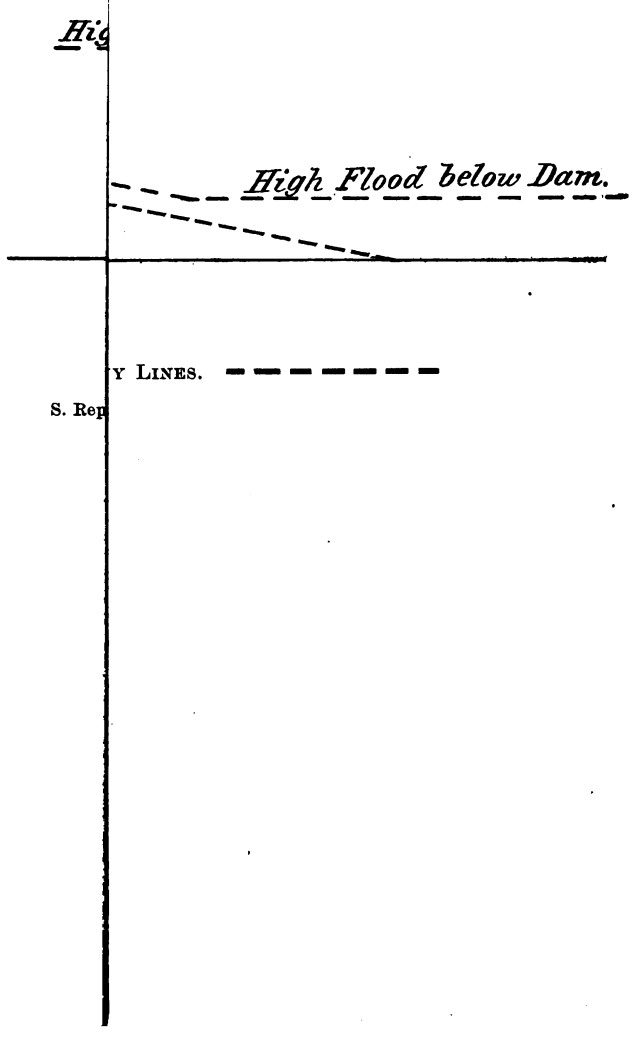
It must be built without these risks and used without them.

To avoid these dangers, the board outlined in some degree the method of construction it would suggest, including the control within certain limits of the portion of the flood waters to be allowed to flow over the dam during construction, its completion in the dry to 120 feet above the sea, and its absolute immunity from the passage of water over its crest and down its slope thereafter.

For myself, the study of the construction of the irrigation weirs of India, the conditions to which they are subjected, and the results, not only in general, but in the very example cited by Mr. Menocal, only confirm my opinion that the precautions and methods contemplated by the board should be followed.

FLOODS IN SAN JUAN RIVER.

Both Mr. Miller and Mr. Menocal take issue with the board in its statement that the canal company estimates the highest flood in the San Juan at Ochoa 63,000 cubic feet per second (see Chicago paper, p. 19), while the board considers that 150,000 are possible, and should be assumed.



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The gentlemen beg the question by asserting that it was assumed that the maximum flood might reach 63,000 cubic feet per second, that this was doubled, and provision made for a discharge of more than this over the weirs, etc.

The board has not questioned the matter of discharging 150,000 cubic feet per second over the weirs.

The board's statement had reference to the maximum flood to be encountered and handled in the construction of the Ochoa Dam and other works, and it remains as correct, from the Chicago and other papers, that 63,000 cubic feet per second is the maximum flood the company has considered handling in this part of its work. The trouble with this flood is not in passing it off when the project is completed, but in handling it during construction. Mr. Menocal claims to have weirs enough to discharge it after completion, but denies that as much as one-half of it will be encountered in construction. See the papers referred to.

Mr. Menocal claims a high flood measurement of 42,000 cubic feet per second, but states that, as the river has been known to rise higher, he adds 50 per cent and assumes 63,000 cubic feet per second. The board's possible 150,000 cubic feet he characterizes as "a rough and excessive guess."

The board had the gauging of 142,000 cubic feet referred to by Mr. Menocal, and while the exact location is not known the cross section is known and approximately the level, and from the data hydraulic formula give approximately the river discharge at its highest recorded elevation, which record of height the company has, to be nearly 125,000 cubic feet per second. Therefore 150,000 is not a rough and excessive guess, but must be approximately correct.

SLOPE IN SAN JUAN RIVER.

The board, in its report, stated that the slope of the river in the dry season would be so small that it would amount to practically nothing instead of 4 feet as estimated in the canal company's project.

Mr. Menocal, in his testimony, adheres to his original estimate of three-fourths of an inch per mile.

My colleague, Mr. Noble, refers to this matter in his statement, and I only make mention here of the fact that Mr. Menocal, in his estimate of the slope, relies solely upon observed slopes in the river under present conditions between the lake and Toro and in the Aguas Muertas. He appears to overlook the great changes in these slopes which must occur when the level of the river surface is raised at Ochoa about 60 feet above its low stage and when the river is dredged from Toro to the lake.

This rise more than doubles the average depth in the Aguas Muertas, and the cross section is increased about 300 per cent, and other conditions reducing its slope are affected accordingly. The ruling conditions from the lake to Toro also will be greatly different when the river is raised.

If the average cross sections of the river, constructed for the board's calculations, are correct, and the coefficient of roughness of the channel is correctly assumed, the hydraulic formula must give approximately correct results for certain discharges. Fortunately an opportunity offered to check these data for one-half the length of the river. Colonel Childs, in his admirable report of his surveys for a ship canal on this route, made in 1852, gives the measured slope of the river from the lake to Toro, and also the height of the lake and the gauged discharge of the lake at the same time.

As the results of the calculations of the board differed so greatly from those assumed in the company's project, I looked patiently for some means of testing our work, and finding these data in Colonel Childs's report I applied our average sections of river bed and coefficients, and with his observed lake elevation and measured discharge, calculated a slope from the lake to Toro of $2\frac{3}{10}$ feet against $2\frac{2}{10}$ feet actually measured by him. This satisfied me that the data used by the board were substantially correct. It is interesting, to show the great change of slope due to the elevation of the lake to 110 feet, and the increased section of the river due to dredging, to note that with the same discharge observed by Colonel Childs, the same data gives, by the same hydraulic formula, a slope of little more than one-half as many inches.

And when the same data and the same formula are applied with a discharge of about 10,000 cubic feet per second, the slope sinks, in this distance of 28 miles, or one-half the distance to Ochoa, to about 1.2 inches, and, manifestly, the slope from Toro to Ochoa is still less. What more is necessary to satisfy Mr. Menocal that the project for a ruling depth of 28 feet of water will fall to one of 24 feet, and as much lower as the lake will fluctuate below 110 feet above the sea?

It is only a question of how much the project will fail in being a 28-foot canal, and in the requirement of article 2 of the concession, now a contract, with the State of Nicaragua, that—

"The canal shall be of sufficient dimensions for the free and commodious passage of vessels of the same size as the large steamers used for ocean navigation in Europe

and America." * * * To give the separate and detailed calculations conducted by members of the board, with all the calculations of coefficients C, and the long and tedious approximations for slope in the application of Kutter's formula, would be not readily understood by any but engineers and mathematicians and would make a considerable document in itself.

Despite the long, tedious, and painstaking labor the board has devoted to the mathematical determination of this slope in 69 miles of the river, from the most carefully obtained data it could obtain, Mr. Menocal declares its results, in his opinion, "unwarranted and inadmissible," as opposed to his guess, for there is no claim or pretense that he or any engineer of the canal company has ever computed or attempted to compute the slope of the San Juan River. He has simply guessed at what it would be when raised to practically the level of the lake by the Ochoa dam from observations of its slope at two sections in the river as it flows to-day between its banks, 18 to 60 feet less in depth than it will be when a part of the sailing route of the canal.